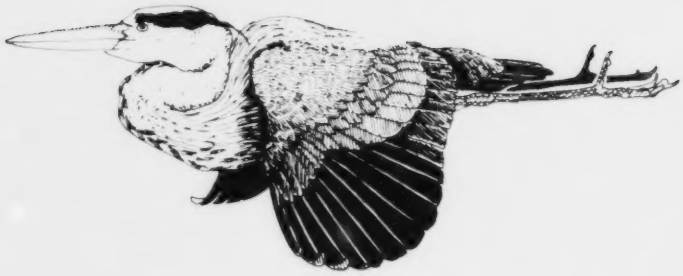
THE BREEDING BIRD SURVEY IN CANADA 1966–1983
ANALYSIS OF TRENDS IN BREEDING BIRD POPULATIONS

B.T. Collins
J.S. Wendt



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ABSTRACT

Results from the Breeding Bird Survey are used to study changes in population of birds in Canada over the period 1966 to 1983. Although some patterns are apparent, such as a decline of many grassland and wetland species in the Canadian prairies, the results are generally more complex. There is a mixture of increases and decreases in population that varies by species and regions. It seems that simple hypotheses attempting to explain trends according to breeding habitat quality, or wintering habitat quality, or climate, will be difficult to support without consideration of the detailed ecological relationships of each species.

The Route Regression Technique, with several weighting factors, is used to produce robust estimators of trend from a multiplicative model. One conclusion of the review of analysis methods is that meaningful estimates of trend present a computation burden that requires a computer for solution.

The Breeding Bird Survey is shown to be an invaluable record of changes in bird numbers. However, the strength of the survey is directly related to the level of volunteer participation. In this context the in-depth statistical analysis presented in this study presents a challenge to survey coordinators who must convince volunteers of the overall value of their contribution, without being able to show simply how each route influences the final results.

RÉSUMÉ

Les résultats du Relevé des oiseaux nicheurs sont utilisés pour étudier les fluctuations des populations d'oiseaux au Canada de 1966 à 1983. Même si certaines tendances sont évidentes, comme le déclin de nombreuses espèces des sols herbageux et des terres humides dans les Prairies canadiennes, les données sont généralement plus complexes. Il y a une combinaison de hausses et de baisses des effectifs, qui varie selon les espèces et les régions. Il semble que les seules hypothèses visant à expliquer les tendances selon la qualité de l'habitat de reproduction, de l'aire d'hivernage ou du climat seront difficiles à vérifier sans prendre en considération les liens écologiques détaillés de chacune des espèces.

La technique de régression dite "Route Regression Technique", avec divers facteurs d'estimation, sert à l'obtention de solides évaluateurs de tendances à partir d'un modèle multiplicatif. Entre autres conclusions, l'étude des méthodes d'analyse indique que les estimations significatives des tendances imposent des calculs compliqués dont la solution requiert l'utilisation d'un ordinateur.

Le Relevé des oiseaux nicheurs constitue un répertoire inestimable des variations du nombre des oiseaux. Cependant, la portée du relevé dépend directement du taux de participation des bénévoles. Dans ce contexte l'analyse statistique fouillée décrite dans la présente étude représente un défi pour les coordonnateurs du relevé, qui doivent convaincre les bénévoles de la valeur d'ensemble de leur contribution sans pouvoir démontrer aisément comment les données de chaque route influencent le résultat global.

THE BREEDING BIRD SURVEY IN CANADA 1966-1983
Analysis of trends in breeding bird populations

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THE BREEDING BIRD SURVEY IN CANADA 1966-1983
Analysis of trends in breeding bird populations

1) INTRODUCTION

1.1) History of the Breeding Bird Survey

The breeding bird survey (BBS) is an important data source for studying the populations of terrestrial birds in North America. The survey was started in 1966 in the United States east of the Mississippi river and in the Canadian Maritime Provinces. In subsequent years it was expanded to cover all of the 48 contiguous states and all 10 provinces and the Yukon Territory of Canada. The survey has been conducted every year since, entirely by volunteer observers.

The efforts made by the BBS volunteers have provided a unique source of information on North American terrestrial bird populations. The data set is maintained by the U.S. Fish and Wildlife Service in Patuxent, Maryland, but the Canadian Wildlife Service maintains a copy of the observations made in Canada and has provided several interim analyses of the results to the Canadian volunteers. For some years the Canadian data files were created independently of those in the U.S.

Annual reports on the Canadian portion of the survey were prepared for the years 1970 to 1980 (Erskine, 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1978; Finney et al., 1978, 1980; Freemark et al., 1979; Silieff and Finney, 1981). These annual reports provided a measure of year-to-year change in species counts based on those routes which were comparable from one year to the next. However, the approach used was not able to detect or quantify long term trends in the populations. As well, fluctuations in the population levels due to unusual events such as a late spring or unusually harsh winter could result in significant annual changes in population levels which were not indicative of long term trends.

A comprehensive analysis of the first 10 years of the BBS in Canada was also prepared (Erskine, 1978). In this report long-term trends in bird populations were studied and explanations of the most significant year-to-year changes and long-term trends that were then apparent were presented.

Erskine multiplied the year-to-year changes in the population index to investigate a trend over time but in a comprehensive look at procedures for the analysis of BBS data, (Geissler and Noon, 1981) it was concluded that this technique was unstable and could lead to misleading suggestions of trend in the population when none occurred. Geissler and Noon examined several methods of estimating long term trends and recommended a procedure based on a within-route regression on the log transformed data. This led

to a comprehensive analysis of changes in breeding bird populations up to 1979 (Robbins et al., 1986). The Geissler and Noon approach has been expanded to allow for observer and disturbance effects (Geissler, 1984).

The present report uses a modification of the Geissler and Noon approach to measure the long-term trends in populations in Canada. This was done to report results of the Canadian portion of the study separately from the continental estimates. The full analysis provides separate estimates of trend for selected species from 6 geographic regions in the country. These regions are shown as regions 1-6 in Figure 1. Regions 7-10 shown in Figure 1 do not have sufficient data bases to allow full statistical analysis by the technique used in this report. To provide a reference to breeding bird survey results as they apply to all species in all regions, indices have been calculated from the full set of data for display in Appendix A.

In the text, the ten regions are referred to by these terms:

1-Maritime Provinces
2-Central Ontario And Quebec
3-Southern Ontario And Quebec
4-Southern Prairie Region
5-Central Prairie Region
6-Southern British Columbia
7-Labrador
8-Routes Not In Study Regions
9-Northern British Columbia And Yukon
10-Newfoundland

1.2) BBS Methods

The field methodology of the BBS survey has been described in detail by several authors (Robbins and Van Velzen, 1970; Erskine, 1978). In brief the program is run as follows. The country is stratified into degree blocks of latitude and longitude. Within each degree block designated BBS routes are laid out following roads. The number of routes in each survey block is limited by the availability of qualified observers and traversable roads. Each route consists of 50 sampling stations at 0.8 Km intervals. The provincial coordinator of the survey contacts observers in early spring each year to determine who will conduct each route. The selected observer is sent information of the suitable timing for the route. Generally the route should be completed during June but the last week of May or the first week of July is acceptable in some areas. Each route is to be started one half hour before sunrise and the starting time is provided to the observer. The observer starts at the first stop and records all birds seen or heard for three minutes. The observer then proceeds to the next stop and repeats the three-minute count until all 50 stations are completed. In addition at the beginning and end of

Figure 1: BBS Regions in Canada

the route the observer records temperature and coded values for sky cover and wind speed.

2) STATISTICAL METHODS

2.1) Transformation of Data

The techniques used in the BBS are unsuited to provide absolute estimates of population density since they are based on roadside counts and hence only study a portion of the breeding range. Further even if it was assumed that the area studied by the BBS routes was representative of the total breeding range the counts could not be considered an absolute density measure since the area over which the birds were counted is not known. The effective area examined during a breeding bird count varies with species and conditions along the route. A sibilant voiced warbler in dense woods can only be heard or seen if close to the observer, while a bobolink in a meadow can be both seen and heard at a distance. The effective area even varies with time, as changes in wind and traffic noise modify the detection range. Thus it seems difficult to consider the BBS counts as more than an index to the density of birds, although correction factors might be feasible for some species (Robbins and van Velzen,1970). Since the data provide only an index to count, one can only measure the relative changes in population. As Geissler and Noon indicate this suggests that population changes should be studied using a multiplicative model, i.e. the changes should be measured relative to the population size. Multiplicative models have been proposed for trend analyses of other wildlife species (Harris, 1986).

Some further reasons, given by Geissler and Noon, for using a multiplicative model are i) the forces which change population levels often act on a proportion of the population rather than on a specific number of individuals, ii) observers probably see or hear a proportion of the birds present and iii) a logarithmic transformation has been found to stabilize the estimated variance (Sen, 1981).

A multiplicative model can be reduced to a linear model by taking the logarithms. However, on many occasions no birds are counted and a simple logarithm cannot be calculated. In this case a small positive constant is usually added to all observations to allow the transformation to be calculated

$$z_{ij} = \log_{10} (y_{ij} + c) \qquad (2.1.1)$$

where y_{ij} denotes the observed count on route i in year j and c is the constant value added to each observation.

Geissler and Noon suggested selecting c=0.5 but had no justification for this choice. In a study of the distribution of the counts of birds (Sen, 1981) it was concluded that the transformed values had an approximately normal distribution with c=1. Again with that study no effort was made to justify the choice of c or to examine other values of c.

In this report c was set equal to 0.23. This value was chosen after a simulation study (Collins, 1989) indicated this was a robust choice which introduced a bias of less than 5% if the average counts were 2 or more. However, if the average counts per route are less than 2 the curve fitting procedure described below can still be appreciably biased.

2.2) Regression On Individual Plots

Geissler and Noon (1981) examined several methods for measuring trends for BBS data and concluded that a parametric regression of the log transformed data with weighting to reduce the variance provided the most precise estimate of trend. The previously used technique of calculating a year to year ratio for comparable plots was shown to be an inefficient use of the data since only data collected in successive years on the same route are used in the calculation.

The trend in an individual route was estimated as follows. For plot i a standard linear regression was performed on the transformed observations, z_{ij}, using the model

$$z_{ij} = A_i + B_i\, t_{ij} + e_{ij} \qquad (2.2.1)$$

where t_{ij} is the year the j-th observation in plot i is taken, A_i and B_i are coefficients of the regression to be estimated from the data and e_{ij} is the discrepancy between the observed value and the model.

The e_{ij} are assumed to be random variables with mean zero. The linear regression calculates estimates of A_i and B_i which minimize the sum of the squared vertical distance between the observed values and the regression line.

2.3) Weighting of Plots

It is necessary to combine the estimates of trend for each plot to create an overall estimate of trend for the region. A simple average of the trends in each plot, however, may not provide a realistic measure of the overall change in population since the observed trends in some plots may be more important than those in other plots. Instead a weighted average of the trends in each plot is used to measure the overall trend in a region. Geissler and Noon gave 3 factors for weighting the slope estimates: i) an

area factor, ii) a slope precision factor and iii) a population density factor.

2.3.1) Area weighting factor

The area factor allows for the differences in the area of land each survey plot represents. The BBS was designed so that each plot was selected from a one degree square block. However, some degree blocks have two or three routes in them and others have routes which were never run. As well some degree blocks, particularly those on shorelines of the oceans or the Great Lakes, contain extensive areas of water which are not included in the sampling scheme. In combining the trends across routes those routes which represent a larger area of land should be given greater weight. In the analysis presented here each degree block is given an area of 1 except those blocks which include major water bodies which have an area equal to the proportion of the block which is land. The active routes were marked on a map to show the degree block in which they started. The weight given to each route in the degree block was equal to the total area of the block divided by the number of routes in it.

2.3.2) Slope precision weighting factor

The slope precision factor adjusts for the differences in the precision of the regression line within each plot. The precision of the estimate of slope depends on the number and spacing of the observations taken on each plot. Plots with more precise estimates should be given more weight. The optimum weighting when calculating the average of a set of independent random variables is inversely proportional to the square root of the variance of the estimates. Under the usual assumptions made in regression analysis the variance of an estimate of trend is given by

$$V(b_i) = \sigma_i^2 / \Sigma(x_{ij} - \bar{x}_{i.})^2 \qquad (2.3.1)$$

where b denotes the estimate of trend, $V(b_i)$ denotes the variance of b_i for route i, σ_i^2 denotes the variance of an observation about the trend line for route i, x_{ij} denotes the year of the j-th observation on route j and $\bar{x}_{i.}$ denotes the average of the years of observation for route i.

The variance term σ_i^2 is both unknown and may vary among plots but it could be estimated from the distance the observed points are away from the predicted line. However, the number of observations within a plot is often too small to provide reliable estimates of the variance and σ_i^2 has been assumed to be constant across plots. Since σ_i^2 is constant it can be dropped from the weighting factor and the slope precision weight has thus been set equal to the square root of the denominator of equation (2.3.2).

This term in the weighting is slightly different than the term proposed by Geissler and Noon. They propose the weighting factor

$$(n_i-1)\ \Sigma\ (x_{ij}-\bar{x}_{i.})^2 \qquad (2.3.2)$$

where n_i is the number of observations for plot i. This factor is approximately proportional to the reciprocal of the square root of the estimated variance of a trend.

2.3.3) Population density weighting factor

Since the estimates of trend are calculated on a logarithmic scale they measure change as a proportion of the population. For example a decline from 100 to 50 individuals in a certain area between years 1 and 5 would give a slope

$$\frac{\log_{10}(100) - \log_{10}(50)}{1-5} = -0.075$$

Consider another area with lower population density, with an increase from 5 to 10 individuals over the same period yielding a slope of

$$\frac{\log_{10}(5) - \log_{10}(10)}{1-5} = 0.075$$

If these two slopes were averaged for the two areas, the result would indicate no change, which is clearly inappropriate since the total population has declined from 105 (=100+5) to 60 (=50+10) individuals. Thus without weighting a decrease of 50% in one plot is cancelled by an increase of 50% in another plot no matter how large the relative populations are in the plots.

Geissler and Noon have suggested weighting by the antilog of the average of the transformed scores i.e.

$$\exp(\Sigma\ z_{ij}/n_i) \qquad (2.3.3)$$

which except for the constant c used in the transformation is the geometric average of the original observations. In this manner routes are given a weight which is proportional to a measure of the number of birds found on the route. This procedure ignores the years in which the observations were taken. Thus for a route where the population is changing the weight given to the route depends on which years observations were taken. For example, Figure 2a shows a route in which the population is decreasing. If observations were taken only in years 1 and 2 then the route would be given a larger weight than if it was observed in years 4 and 5. This suggests that the weighting of routes observed in different years using formula (2.3.3) may not reflect the relative populations of birds seen on the route.

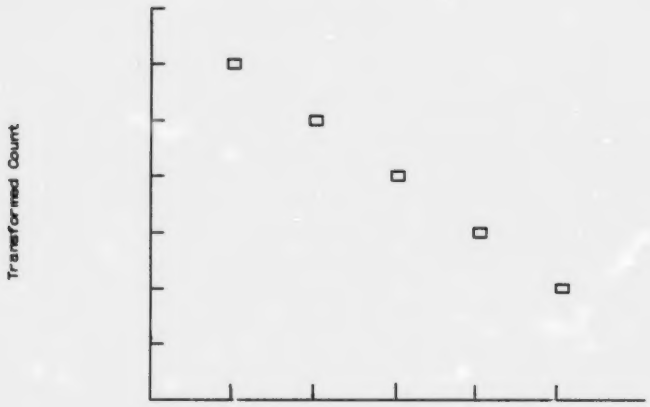

Figure 2a: Example illustrating weighting

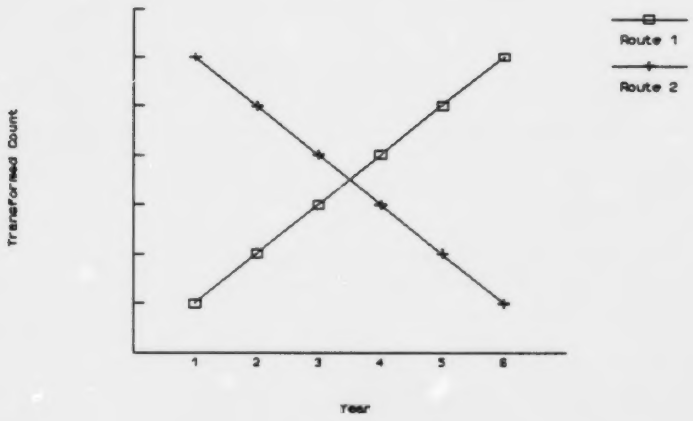

Figure 2b: Example illustrating weighting

In this analysis another method of assigning the relative population size of the routes was used. Since a regression of the z_{ij} on the years of observation has already been calculated, the predicted value of the transformed population count (say z_{i0}) in a fixed year (say x_{i0}) can be calculated

$$z_{i0} = \bar{z}_{i.} + b_i(x_{i0} - \bar{x}_{i.}) \qquad (2.3.4)$$

from which an estimate of the population in the given year can be calculated

$$y_{i0} = \exp(z_{i0}) \qquad (2.3.5)$$

The choice of the year (x_{i0}) in which the population size is predicted makes a substantial difference in the weighting of the routes. For example Figure 2b shows two routes which exhibit perfect linear trends but with observations in the exact opposite order i.e. route 1 goes from a low to a high level while route 2 shows a decline. If the routes were weighted by the predicted level in year 1 then route 2 would be given a higher weight and the weighted average of the two routes would indicate a decline. If they were weighted by the predicted population in year 5 then route 1 would be weighted higher and the weighted average would indicate an increase. Thus using the predicted level at the initial (final) year of the observations as a weighting factor gives maximum influence to routes which show a decline (increase). To avoid this problem the predicted value at the year halfway between the initial and final year of observation in the data set was used as the weighting factor. Since the accuracy of the prediction for a regression line decreases as the distance from the $\bar{x}_{i.}$ increases, the choice of the midrange year also has the advantage of usually using a more accurate prediction of the population size than a predicted level at the extremes of the observation range.

Some BBS routes, however, were run for only a few years at the beginning of the program and then dropped or were only initiated near the end of the time-frame under study. For such routes estimating the population for that route in the year midway between the initial and final years involves extrapolating the data well beyond the observed range of values and can assign unrealistically high weights to some routes. In order to avoid this any population density weights above 100 were replaced by 100. The value 100 was chosen after examining the predicted counts from several analyses of actual data.

2.4) Selection of data

The behaviour of birds varies with the date and time of day. In addition, individual observers vary in their ability to detect birds. The inclusion of data collected over a wide range of times of day and days of the year by different observers would increase the variability in the data and reduce the precision in estimates made from the data. This problem is reduced as much as possible by specifying the timing of the survey to the observers and by the provincial coordinator's efforts to retain the same observer on a route from year to year. In order to improve comparability of observations along a route, the set of observations for a route were divided into subsets called subroutes which consisted of runs which all started within 20 minutes of each other and which were run on dates within 14 days of each other. Each route was divided into as few subroutes as possible which met the above criteria. In some instances when a route was run in a given year under conditions which were substantially different from those in other years it was discarded from the data set. In addition any routes run only once or any observer which contributed only once were discarded from the data set for analysis.

The number of routes run in each region and the number included in the final analysis is shown in table 1. During the processing of the data it was noted that there was an error in the data selection program and the analysis for regions 1 and 2 left out some valid data from the analysis. Thus the counts of number of routes run shown for these two regions are smaller than they should be. This omission will reduce the precision of the estimators but does not bias the results.

2.5) Adjustments for observer and weather effects

It was realized by the organizers of the BBS program that weather will influence the results of the survey and they prescribed that the routes be run under satisfactory weather conditions to enhance comparability of results. The survey instructions request that the survey be run under conditions of good visibility, little or no precipitation and light winds. Even within the imposed conditions there is some effect due to weather conditions and an analysis of variance procedure was applied to the data prior to the analysis for trends to remove the influence of weather and observer.

This was done as follows. The transformed data were submitted to analysis of variance using the model

$$z_{ij} = \mu + r_i + o_k + \beta_1 c_{ij} + \beta_2 c_{ij}^2 + \beta_3 s_{ij} + \beta_4 s_{ij}^2 + \beta_5 t_{ij} + \beta_6 t_{ij}^2 + \alpha_j x_{ij} + e_{ij} \qquad (2.5.1)$$

where z_{ij} is the transformed count for the j-th observation on route i, μ is the overall mean count, r_i is the effect of route i, o_k is the effect of observer k where k denotes the observer doing the j-th observation on route i, c_{ij} is the effective sky cover for the j-th observation on route i, s_{ij} is the effective wind speed for the j-th observation on route i, t_{ij} is the effective temperature for the j-th observation on route i, β_h (h=1,2,3,...6) are coefficients of the weather effects which must be estimated , x_{ij} is the actual year the j-th observation on route i was taken, α_j is the effect of year j and e_{ij} is the random deviation between the model and the data.

It can be seen that the above model allows for both a linear and a quadratic term in the calculation of the effects of the weather conditions. The effective temperature, wind speed and sky cover for the route were defined as weighted averages of the initial and final observations of these variables. The weighting factor was calculated separately for each species of bird as follows. The number of birds counted in each block of 10 stops over the period of the survey was calculated say T_1, T_2, T_3, T_4 and T_5. If it is assumed that the weather conditions changed linearly from the initial stop to the final stop then the average conditions under which birds of this species are seen would be given by

$$R_i\ (1-F) \ + R_f\ F \qquad (2.5.2)$$

where R_i denotes the initial weather conditions, R_f denotes the final weather conditions,

$$F = \frac{\sum_{K=1}^{5} T_K(10K-5.5)}{49 \sum_{K=1}^{5} T_K} \qquad (2.5.3)$$

Model 2.5.1 was fitted using the GLM procedure in the SAS data analysis package. The estimates of the parameters were then used to reconstitute the transformed counts adjusted for the effects of observer and weather conditions in a manner similar to the calculation of partial residuals viz.,

$$z_{ij} = \mu + r_i + o_. + \alpha_j x_{ij} + 55\beta_1 + 55^2\beta_2 + e_{ij} \qquad (2.5.4)$$

where $o_.$ denotes the average observer effect. This calculation estimates what the count would have been under a standard weather condition of zero for sky condition and wind and a temperature of 55° F.

In performing the above calculations it was seen that the estimates of observer effect were often zero. Examination of the data revealed that this was due to the observer effect being confounded with a route effect i.e. it was impossible to distinguish between observer and route when one observer was responsible for all data collected for one or more routes. Thus the difference between the average count on that route and the other routes could be attributed to observer bias or to route effect. Thus this manner of adjusting for observer effects is not completely effective.

2.6) Testing Significance

Significance of the trends was determined by a permutation test. The test was conducted by randomizing the order of the observations separately within each route and calculating the trend statistic for this random reordering of the data. This procedure was repeated 1000 times and the observed trend was declared significant if the absolute value of the observed trend was exceeded by the random trends less than 5% of the time.

Geissler and Noon (1981) proposed using a jackknife procedure to test for the significance of trends. The two tests use different aspects of the data set to assess significance. The jackknife test uses the consistency of the individual route estimates of trend to determine the precision of the overall estimate of trend while the permutation test compares the observed trend to that which would have arisen if there were no trend in the data and the variation in the levels from year to year is caused purely by chance.

Summarizing the trend over the entire survey period may not be suitable for some data sets. The underlying causes of trends in bird populations may not be in effect for the entire time frame of the survey. Hence, the trend analysis was done over five time periods: i) from the start of the survey through 1979, ii) from 1979 through 1983, ii) from the start of the survey through 1974, iv) from 1974 through 1983 and v) from the start of the survey through 1983. The survey was initialized at different times in the different regions. In some regions there were only a few routes in the initial year of the survey and in such circumstances the initial year was dropped from the analysis. The time spans shown in table 1 show the actual frame for the analysis.

TABLE 1 Total Number of Routes Through 1983 by Region and Related Information on the Analysis for Trends

Region	Total Number of Routes Run	Total Number of Routes Used in the Analysis	Number of Different Routes Used in the Analysis	Number of Subroutes Used in the Analysis	Time Span	Number of Observers Used in the Analysis
Maritime Provinces	465	416	51	73	1966-83	52
Central Ontario and Quebec	676	583	73	94	1967-83	76
Southern Ontario and Quebec	564	492	41	64	1967-83	60
Southern Prairie Region	423	367	43	64	1968-83	47
Central Prairie Region	502	409	52	74	1968-83	52
Southern British Columbia	483	401	62	77	1968-83	58

3) RESULTS

3.1) Trend analysis for individual species

The results are shown in tables 2-7 for regions 1-6, respectively. The tables show the estimated trend for each time period analyzed, the corresponding percentage change over a ten-year period, and the results of the permutation test. In addition, for each species the total number of birds recorded on routes entered into the analysis is shown.

In the following discussion trends were denoted significant at the 5% level using the permutation test described in section 2.6. Only those results which show some significance or which can be compared across regions are described below.

It is important to contrast the ideas of statistical significance with biological significance. The statistical significance tells us about the magnitude of the trend in relation to the variability in results and the sample size (number of routes done). Biological significance is a less clear notion, but in this context we can take it to refer to a change that is of importance to a species' long-term prospects. In the BBS we could carry out an analysis every year, and find significant changes in many species' populations. It is clear that populations do change every year, and, especially for passerine species, the real annual changes may be a large proportion of the population size. Such changes are significant, in the statistical sense, but often lack biological significance unless they are continued over an extended period. That is why the following tables show trend analysis for time periods that include several annual cycles.

Table 2 Results of analysis for trend for region 1 (the Maritime Provinces)

Common Name	Number Recor.	Trend Over Time 1966-79	1979-83	1966-74	1974-83	1966-83
Double-Crstd. Cormorant	3288	-72.	105.	-93.	285.	-62.
Herring Gull	7477	-53.*	905.	-28.	30.	-38.*
Yellow-Bel. Sapsucker	3406	-28.	-54.	-36.	-45.	-51.*
Least Flycatcher	2385	-31.*	-14.	-37.	-12.	-36.*
Tree Swallow	6515	-14.	-9.	-25.	42.*	-12.
Bank Swallow	6585	91.	111.	91.	-6.	16.
Cliff Swallow	2182	42.	-93.	358.	96.	19.
Barn Swallow	9347	26.	46.	78.*	-9.	-14.
Blue Jay	2033	1.	140.	-35.	-33.	-9.
American Crow	11893	-19.*	84.	0.	22.*	-6.
Common Raven	4606	-9.	332.*	66.	77.	13.
Winter Wren	2275	-45.*	6152.*	138.	-69.*	-36.*
Ruby-Crowned Kinglet	4885	-32.*	-53.	18.	-76.*	-47.*
Veery	5488	60.*	40.	59.	27.	50.*
Swainson's Thrush	9336	31.*	-49.	45.*	-9.	9.
Hermit Thrush	3576	-6.	183.	81.	-18.	-12.
American Robin	24551	-8.*	19.	7.	-18.*	-11.*
European Starling	17744	-25.*	-32.	-21.	-49.*	-30.*
Red-Eyed Vireo	6618	106.*	-26.	184.*	-12.	57.*
Tennessee Warbler	3440	238.*	90.	420.*	-29.	147.*
Nashville Warbler	2774	1.	172.*	98.	-10.	6.
Northern Parula	2199	106.*	-6.	196.*	77.*	71.*
Yellow Warbler	4336	48.*	126.	96.*	50.*	43.*
Chestnut-Sided Warbler	2168	42.	190.	93.	-33.	10.
Magnolia Warbler	6374	13.	29.	-19.	125.*	37.*
Black-Thr. Green Warbler	2562	38.	232.*	294.	11.	29.
American Redstart	8978	64.*	82.	61.	35.*	54.*
Ovenbird	7401	68.*	79.*	141.*	8.	50.*
Common Yellowthroat	9749	-13.*	21.	-35.*	28.*	-6.
Rose-Breasted Grosbeak	2671	433.*	148.	779.*	-18.	261.*
Chipping Sparrow	4420	-19.*	15.	-24.	25.	-6.
Savannah Sparrow	4272	-33.*	60.	-52.*	-60.*	-39.*
Song Sparrow	11612	-28.*	32.	-6.	-33.*	-27.*
White-Throated Sparrow	22484	-22.*	-31.	-8.	-40.*	-27.*
Slate-Coloured Junco	5263	-36.*	19.	-21.	-32.*	-37.*
Bobolink	7739	79.*	96.*	186.*	-0.	60.*
Red-Winged Blackbird	8906	133.*	-74.*	228.*	-41.*	52.*
Common Grackle	9105	-40.*	-43.	-65.*	-8.	-33.*
Brown-Headed Cowbird	3569	-65.*	-48.	-89.*	-43.	-57.*
Purple Finch	4080	-31.*	146.	-20.	-23.	-34.*
American Goldfinch	5159	-27.*	53.	-39.*	-11.	-22.*
Evening Grosbeak	9711	21.	374.	510.*	0.	10.
House Sparrow	5927	-51.*	-69.*	-55.*	-49.*	-46.*

- trends are shown as the percentage change which would take place over ten years
- * significant ($p<0.05$)

Table 3 Results of analysis for trend for region 2 (Central Ontario and Quebec)

Common Name	Number Recor.	Trend Over Time 1966-79	1979-83	1966-74	1974-83	1966-83
Killdeer	2849	34.	-74.*	-20.	-12.	-4.
Ring-Billed Gull	6603	72.	-33.	-99.	1622.*	508.*
Herring Gull	8288	-54.*	743.	-54.	146.	19.
Yellow-Shafted Flicker	2234	-65.*	-23.	-56.	-4.	-28.
Least Flycatcher	4934	-9.	-68.	19.	-53.*	-32.*
Tree Swallow	3921	24.	-80.*	-65.	-35.	-16.
Bank Swallow	4690	-67.	709.*	-97.	55.	-29.
Cliff Swallow	3755	-76.	46.	-85.	-16.	-37.
Barn Swallow	7999	-25.	-62.*	-28.	25.	-4.
Blue Jay	2179	-38.	300.	-61.	0.	-30.
American Crow	15252	-21.*	43.	-14.	45.*	-0.
Common Raven	4165	43.	124.	-61.	119.*	62.*
Winter Wren	2751	-83.*	314.*	13.	-0.	-53.
Ruby-Crowned Kinglet	3063	-80.*	431.	165.	-26.	-46.
Veery	12217	-0.	-49.	13.	-10.	-3.
Swainson's Thrush	7560	-12.	-23.	-47.	32.	-5.
Hermit Thrush	4047	-46.	-38.	-57.	-45.*	-51.*
American Robin	18910	-10.	37.*	-13.	16.*	1.
Cedar Waxwing	4128	49.	-87.	-63.	120.	-44.
European Starling	22505	-23.	-23.	-48.	-54.*	-38.*
Red-Eyed Vireo	17993	-0.	218.*	-24.	68.*	-24.
Tennessee Warbler	2230	-90.	170.	-53.	-37.	-88.*
Nashville Warbler	6064	-6.	64.	124.	90.	32.
Yellow Warbler	2628	0.	135.*	-60.	46.*	19.
Chestnut-Sided Warbler	9483	8.	9.	109.	-21.*	-0.
Magnolia Warbler	2886	5.	-7.	-26.	183.*	-14.
Yellow-Rumped Warbler	2790	-27.	31.	-87.	148.*	-1.
American Redstart	4126	-35.	-39.	20.	-10.	-30.*
Ovenbird	12622	15.	-14.	45.	17.*	16.*
Mourning Warbler	6015	8.	16.	-11.	8.	13.
Common Yellowthroat	8920	-10.	-19.	-4.	-14.	-14.*
Rose-Breasted Grosbeak	3606	103.*	110.	224.	-4.	42.*
Chipping Sparrow	8383	21.	-36.	-0.	35.	12.
Savannah Sparrow	8156	37.*	-29.	44.	-19.	8.
Song Sparrow	10589	-38.*	-2.	-19.	-42.*	-37.*
White-Throated Sparrow	25155	-27.*	18.	12.	-34.*	-27.*
Bobolink	8307	41.*	51.	30.	47.*	42.*
Red-Winged Blackbird	14045	52.*	-50.*	82.	-3.	12.
Common Grackle	8286	-13.	-37.	-18.	-13.	-20.
Brown-Headed Cowbird	4580	60.	-80.	-65.	-67.*	-26.
American Goldfinch	4131	-36.*	44.	-91.*	-20.	-42.*
Evening Grosbeak	4439	65.	1.	-31.	34.	-59.
House Sparrow	4694	-49.*	-38.	-21.	-62.*	-44.*

- trends are shown as the percentage change which would take place over ten years

Table 4 Results of analysis for trend for region 3 (Southern Ontario and Quebec)

Common Name	Number Recor.	Trend Over Time 1966-79	1979-83	1966-74	1974-83	1966-83
Mallard	2085	80.*	10299.	290.	-48.	63.
Killdeer	9105	26.*	-33.	24.	-18.*	8.
Ring-Billed Gull	9741	738.	1567.*	194.	659.*	877.*
Mourning Dove	8055	43.*	-22.	45.	28.*	41.*
Rock Dove	9222	60.*	-11.	-22.	61.*	47.*
Yellow-Shafted Flicker	2665	-43.*	-21.	-64.*	-18.	-29.*
Gt. Crested Flycatcher	2714	-23.	213.	-22.	47.	-1.
Eastern Kingbird	4726	21.	-26.	-27.	2.	14.
Horned Lark	3168	-28.*	-6.	-69.*	76.	1.
Purple Martin	2473	-21.	-64.	17.	-23.	-20.
Tree Swallow	6090	33.	210.*	-40.	88.*	57.*
Bank Swallow	16131	-17.	-69.	-95.*	-48.	-13.
Barn Swallow	19060	27.*	-26.	4.	16.	16.*
Blue Jay	2496	1.	184.*	-1.	31.	31.*
American Crow	23291	-13.*	95.*	-14.	10.	-7.
House Wren	2420	56.	-25.	154.	-53.*	12.
Veery	2529	-25.*	-64.*	-63.*	-34.*	-29.*
American Robin	26521	-8.	57.*	15.	7.	1.
Gray Catbird	2130	20.	-85.*	-55.	-0.	5.
Brown Thrasher	2369	-15.	62.	25.	-32.*	-23.*
Cedar Waxwing	3887	62.	485.	24.	179.*	83.*
European Starling	80085	-25.*	80.	-32.	-25.*	-19.*
Warbling Vireo	2277	18.	268.	-83.	212.*	74.*
Red-Eyed Vireo	3185	-3.	567.	-15.	-26.*	-13.*
Yellow Warbler	4293	-7.	153.*	-18.	72.*	24.*
Common Yellowthroat	5027	13.	419.*	-20.	14.	22.*
Rose-Breasted Grosbeak	2960	46.*	68.	-9.	20.	51.*
Chipping Sparrow	6688	-17.*	37.	-42.*	-7.	-6.
Vesper Sparrow	3778	-38.	-47.	-84.*	-33.	-41.*
Savannah Sparrow	25809	-2.	-50.*	-43.*	-32.*	-23.*
Song Sparrow	19110	-24.*	81.*	-14.	3.	-11.
White-Throated Sparrow	3269	6.	159.*	4.	-35.	-3.
Bobolink	25550	17.*	12.	-2.	7.	9.
Red-Winged Blackbird	82582	43.*	-9.	73.*	-9.	19.*
Eastern Meadowlark	13383	-43.*	13.	-34.*	-53.*	-47.*
Common Grackle	39450	-35.*	22.	-29.	-15.	-27.*
Brown-Headed Cowbird	11448	-20.*	77.	-5.	-44.*	-27.*
Baltimore Oriole	4830	17.	6.	-10.	7.	13.
American Goldfinch	10768	-47.*	158.*	-75.*	-6.	-30.*
House Sparrow	35693	-7.	31.	-25.	7.	-0.

- trends are shown as the percentage change which would take place over ten years
- * significant ($p<0.05$)

Table 5 Results of analysis for trend for region 4 (the Southern Prairie region)

Common Name	Number Recor.	Trend Over Time 1966-79	1979-83	1966-74	1974-83	1966-83
Mallard	13965	46.	34.	1.	19.	32.
Northern Pintail	5349	-35.	478.	-83.	-83.*	-59.*
Blue-Winged Teal	3601	17.	106.	5.	-67.*	-31.
Northern Shoveler	2361	547.	610.	-85.	71.	-34.
American Wigeon	2010	56.	494.	130.	34.	7.
Lesser Scaup	3229	-48.	643.	-57.	-54.	-13.
American Coot	3634	-48.	144.	-71.	-58.	-60.*
Killdeer	5336	22.	28.	51.	-29.*	-6.
Marbled Godwit	2008	44.	0.	-88.	82.*	33.
Franklin's Gull	6254	-52.	74373.	-75.	-96.*	-85.*
Ring-Billed Gull	6936	-48.*	481.	-80.	94.	-7.
Black Tern	3133	-77.*	245.	-80.	-45.	-79.*
Mourning Dove	5157	17.	106.	-35.	79.*	36.*
Rock Dove	3046	-14.	60.	-93.	3.	16.
Eastern Kingbird	2505	-9.	47.	-51.	-8.	-8.
Horned Lark	35429	7.	23.	32.	-3.	9.
Cliff Swallow	6481	50.	281.	-89.	-28.	10.
Barn Swallow	5699	6.	6.	-17.	8.	9.
Black-Billed Magpie	3756	-27.	137.	-61.	11.	-10.
American Crow	14907	-14.	25.	-61.*	-2.	-8.
House Wren	4588	34.*	25.	-47.	80.*	49.*
American Robin	2566	56.*	222.	-62.	71.*	67.*
European Starling	7573	23.	108.	213.	-8.	8.
Clay-Coloured Sparrow	8686	34.*	151.	104.*	-32.*	-1.
Vesper Sparrow	7230	-16.	127.	-6.	50.*	22.
Lark Bunting	2818	-95.*	1606.	-95.	-4.	-38.
Savannah Sparrow	8341	-12.	172.	143.	-2.	14.
Song Sparrow	3133	-45.*	27.	-36.	-53.*	-37.*
McCown's Longspur	3194	113.	777.	827.	178.	-18.
Chestnut-Col. Longspur	8436	20.	35.	-15.	12.	20.
Red-Winged Blackbird	36912	32.*	19.	172.*	-29.*	-6.
Western Meadowlark	23053	-48.*	118.	-24.	-27.*	-31.*
Yellow-Headed Blackbird	7697	30.	61.	177.	49.	26.
Brewer's Blackbird	9966	14.	136.	143.	-23.	-5.
Common Grackle	2003	12.	36.	-78.	29.	4.
Brown-Headed Cowbird	10477	31.	35.	4.	-3.	16.
House Sparrow	25616	11.	121.	109.	-4.	5.

- trends are shown as the percentage change which would take place over ten years
- * significant ($p<0.05$)

Table 6 Results of analysis for trend for region 5 (the Central Prairie region)

Common Name	Number Recor.	Trend Over Time 1966-79	1979-83	1966-74	1974-83	1966-83
Mallard	11445	-12.	77.	422.	-23.	-5.
Blue-Winged Teal	3085	143.	127.	351.	-37.	-1.
Lesser Scaup	2793	-26.	229.	456.	-65.*	-60.
American Coot	2321	12.	909.	-43.	-52.*	-28.
Killdeer	3685	-22.	60.	33.	-37.*	-31.*
Common Snipe	2739	78.	12.	208.	-45.*	5.
Franklin's Gull	6080	-92.	59.	-94.	-74.	-88.*
Black Tern	3460	-13.	2170.	-96.	-47.*	-35.
Mourning Dove	2528	-36.	71.	-88.	41.	10.
Alder Flycatcher	2459	273.	1.	-100.	95.	219.
Least Flycatcher	4312	34.	113.	-57.	25.	20.
Horned Lark	2419	-24.	5.	-78.	-30.	-34.*
Tree Swallow	2360	19.	43.	-96.	-27.	-34.
Cliff Swallow	7262	-82.	287.	-66.	-63.	-56.
Barn Swallow	6297	53.*	32.	94.	26.	34.*
Black-Billed Magpie	5319	-31.	26.	-53.	-13.	-7.
American Crow	17461	-18.*	56.	-28.	-15.*	-19.*
House Wren	7210	-10.	12.	3.	13.	-2.
Swainson's Thrush	2103	-79.	69.	239.	959.*	140.
American Robin	7842	6.	30.	-45.	12.	5.
European Starling	9911	-5.	193.	-23.	-2.	-8.
Warbling Vireo	2262	-32.	75.	-100.*	150.*	64.*
Red-Eyed Vireo	6353	261.*	8.	-99.	106.*	76.*
Yellow Warbler	4641	-39.	3.	-71.	-0.	-22.*
Common Yellowthroat	2634	69.	111.	-47.	-25.	0.
Chipping Sparrow	3803	-4.	4.	-89.	11.	9.
Clay-Coloured Sparrow	13150	-9.	65.	-11.	-26.*	-14.*
Vesper Sparrow	5364	-43.	255.	-90.	22.	0.
Savannah Sparrow	5420	15.	44.	-40.	-21.	9.
Song Sparrow	8954	-36.	34.	0.	-39.*	-38.*
White-Throated Sparrow	3134	-48.*	6.	-97.*	-14.	-26.*
Red-Winged Blackbird	24227	30.*	11.	76.	-17.*	-0.
Western Meadowlark	6042	-58.*	244.	-25.	-26.	-32.*
Yellow-Headed Blackbird	3743	143.	16.	-80.	60.	67.
Brewer's Blackbird	10277	11.	16.	58.	-39.*	4.
Brown-Headed Cowbird	6043	8.	64.	-24.	-38.*	-8.
Baltimore Oriole	2366	-18.	1.	-6.	-3.	-7.
Pine Siskin	2129	-87.	297.	-100.	-89.*	-89.*
American Goldfinch	2911	-1.	246.	-99.	138.*	145.*
House Sparrow	7438	22.	45.	-7.	-26.	-18.

- trends are shown as the percentage change which would take place over ten years
- * significant ($p<0.05$)

Table 7 Results of analysis for trend for region 6 (Southern British Columbia)

Common Name	Number Recor.	Trend Over Time 1966-79	1979-83	1966-74	1974-83	1966-83
Glaucous-Winged Gull	3541	1728.	-93.	-100.	113.	145.
Red-Shafted Flicker	2136	182.	-74.*	-59.	-31.	4.
Western Wood-Pewee	2199	-70.*	-68.*	-86.	-43.*	-42.*
Hammond's Flycatcher	2397	23.	-96.	100.	8.	-12.
Tree Swallow	3527	62.	87.	404.	107.	100.*
Violet-Green Swallow	3196	-33.	3.	-79.	79.	-9.
Cliff Swallow	3251	-22.	164.	565.	161.	-28.
Barn Swallow	7322	151.	-41.	8999.*	21.	34.
American Crow	8964	70.*	107.	1449.	28.	45.*
Northwestern Crow	5116	58.	-38.	-92.	63.	-1.
Common Raven	2900	129.	-80.*	-98.	104.	48.
Black-Capped Chickadee	3175	-3.	-17.	3615.	-17.	-18.
Chestnut-Backed Chickadee	2450	-6.	-41.	-96.	48.	-3.
Winter Wren	2109	142.*	246.*	113.	58.*	80.*
Ruby-Crowned Kinglet	2044	568.*	-14.	284.	-58.	-11.
Swainson's Thrush	13070	15.	-26.	50.	-33.*	-24.*
American Robin	24731	9.	-43.	21.	-16.	-13.
Varied Thrush	2466	2.	52.	140.	11.	12.
European Starling	22904	-7.	102.	-28.	11.	4.
Warbling Vireo	3306	86.	62.	4947.*	-11.	11.
Red-Eyed Vireo	4073	122.	-65.*	-73.	22.	19.
Orange-Crowned Warbler	2740	9.	-50.	306.	-30.	-32.
Yellow Warbler	3517	-11.	-79.	-71.	-44.*	-20.
Audubon's Warbler	3631	150.	-29.	67198.*	-33.	-3.
MacGillivray's Warbler	3458	28.	-27.	-86.	88.*	42.
Western Tanager	2483	278.*	-7.	431.	-29.	10.
Chipping Sparrow	6347	-9.	-61.	-80.	-52.*	-32.*
Savannah Sparrow	2194	431.	114.	397.	29.	135.
Song Sparrow	4553	77.	33.	734.*	-55.	-2.
Oregon Junco	5842	32.	61.	-75.	32.	38.*
Red-Winged Blackbird	3940	29.	-54.	578.	42.	22.
Western Meadowlark	3293	-40.	-49.*	-62.	-18.	-29.*
Brewer's Blackbird	6028	-24.	-78.	-41.	-52.*	-47.*
Brown-Headed Cowbird	3711	82.	-71.	-30.	-42.*	-13.
Red Crossbill	2135	-22.	3.	-100.	172.	36.
Pine Siskin	9729	-8.	-88.*	-27.	-68.*	-29.
House Sparrow	2709	-48.	111.	-98.	-32.	-33.

- trends are shown as the percentage change which would take place over ten years
- * significant ($p<0.05$)

3.2) Comments on trend analysis results for selected species

Mallard

The Mallard population was estimated to increase in both Southern Ontario and Quebec, and the Southern Prairie Region and to be stable in the Central Prairie Region but none of these trends were significant. The increase of the Mallard in Southern Ontario (which is included in region 3) is well known but the increase in the Southern Prairie Region is directly opposite of the known trends for this species found by waterfowl surveys carried out in the prairie provinces by the U.S. Fish and Wildlife Service. Erskine (1978) also found a general disagreement between results from the BBS and those aerial surveys. He concluded that the main reason for discrepancy was the timing of the surveys, the BBS being in June and the aerial surveys being in May. Erskine's conclusion points out that the BBS, by aiming for the time of year best suited to detect breeding passerine birds, misses that period when most Mallard pairs can be counted on the breeding grounds. By June most Mallard females that have been successful on the first breeding attempt will be incubating eggs or caring for young, and their mates will have abandoned them (Bellrose, 1978). Most females, then, will be difficult to detect in the BBS, and many males will be congregated in moulting areas that may not be indicative of breeding densities in the wider region.

A summary of the results of the U.S. Fish and Wildlife Service aerial surveys of those species discussed in this section is given in Appendix B.

Northern Pintail

Northern Pintail were estimated to have declined significantly in the Southern Prairie Region. The estimates of trend for all subperiods was a decline of similar magnitude suggesting the model of a continual decline over the entire time period was appropriate. Like Mallards, Pintails usually nest before the BBS, so we might expect some discrepancy with the U.S. Fish and Wildlife surveys flown in May. In this case, however, the surveys agree in indicating serious declines in Pintail over the period. An overall population decline will eventually affect all components of the population, including birds in moulting areas, and feeding areas as well as breeding areas, so that discrepancies as noted for the Mallard will disappear in the face of gross changes. It is worth noting that the relative decline of Pintails, as indicated by the aerial surveys in Appendix B, is much greater than for the Mallard.

Blue-winged Teal

Blue-winged Teal were estimated to have declined in the Southern Prairie Region and to have been stable in the Central Prairie Region but these trends were not significant. The Blue-winged Teal is a later nester than the Mallard, so the survey timing problem discussed for the Mallard is not as serious for this species. The survey results are consistent with those shown in Appendix B.

Lesser Scaup

Lesser Scaup were estimated to have declined for the Southern Prairie Region and the Central Prairie Region. This estimate was consistent over all subperiods for the Southern Prairie Region but varies between declines and increases for the Central Prairie Region when subperiods were examined. The chronology of lesser Scaup nesting is well matched to BBS routes carried out in June. The aerial surveys, represented in Appendix B, are not as well timed for Scaup, as they regularly count migrating individuals of unknown breeding status. The trend in scaup from Appendix B is counter to what is expected from habitat conditions, and in this case the BBS provides the better index.

American Coot

The population of American coot is estimated to have declined for the Southern Prairie Region and the Central Prairie Region. For the Southern Prairie Region the decline was significant. For both regions the estimates of trend were declines for all but one of the subperiods analyzed and significant for the Central Prairie Region for subperiods 1979-1983 and 1974-1983. The American coot is counted by the U.S. Fish and Wildlife Service, for which counts see Appendix B. The BBS trend agrees with changes noted in the aerial surveys in the Southern Region, but the aerial surveys indicate an increase in coot in the Central Region between the time periods 1966-77 and 1978-83.

Killdeer

The killdeer nests in open habitat over most of the BBS area. It is obvious and easy to identify, and does not nest in colonies. The BBS methodology is, therefore, well suited to the monitoring of this species, although in some cases the young will have left the nest before the survey route is carried out. Killdeer showed no significant increase or decline, and were remarkably stable in Central Ontario and Quebec, Southern Ontario and Quebec, and Southern British Columbia.

Franklin's Gull

Significant declines in Franklin's gull were recorded in the Southern Prairie Region and the Central Prairie Region. The Franklin's gull has a substantial component of non-breeders in the breeding season population. The BBS takes no note of whether birds are counted on colonies, or on feeding areas that may be located at some distance from breeding colonies. Thus the BBS trend applies to a mixture of breeding and non-breeding birds of these species, with added uncertainty because we do not know which (if any) survey routes are sampling birds at colonies.

Ring-billed Gull

Significant increases in ring-billed gulls were recorded for the period 1967-1983 in Central and Southern Ontario and Quebec. For Southern Ontario and Quebec increases of similar magnitude were estimated for each of the subperiods and were significant for some subperiods. For Central Ontario and Quebec the estimated trend for the subperiods varied between increases and decreases. Thus the assumption of a constant trend over time appears reasonable for Southern Ontario and Quebec.

The ring-billed gull, like the previous species, is a colonial nester, so a more accurate way to sample its numbers is by counts at colonies rather than by the geographically randomized counts used in the BBS. Basing their estimates on a review of counts at colonies, Blokpoel and Tessier (1986) calculated that Great Lakes ring-billed gulls increased at an annual rate of 7.9% from 1967-76 and 11.0% from 1976-84.

Black Tern

A significant decline in Black Terns was found for the Southern Prairie Region. For the Central Prairie Region, the estimated population trend was downward for all time periods analyzed with the trends in two of these periods: 1979-1983 and 1974-1983 being significant.

While this species ranges over much of southern Canada, it is commonest in the prairies (Godfrey, 1986). There it is a familiar and obvious summer resident in marshes and other water bodies, where it feeds primarily on insects. Although Black Terns are distributed somewhat unevenly in colonies on water bodies, the BBS is still reasonably well suited to detecting changes in its population.

Rock Dove

Most observations of rock doves in the BBS are of birds in and around buildings, especially farm buildings. At one time rock doves must have found nesting sites away from human habitations, but they are now largely dependent on human society for shelter and feeding opportunities. Rock doves breed at various times during the year, even in the winter. Thus the BBS results relate to visible individuals, without reference to their breeding status, in most cases.

Mourning Dove

Increases in mourning doves were estimated to have occurred for Southern Ontario and Quebec, the Southern Prairie Region and the Central Prairie Region with the increase in Southern Ontario and Quebec and the Southern Prairie Region being significant.

The mourning dove is hunted in Canada, but only in southern British Columbia. In contrast, this is the migratory species most often shot in North America as a whole. Keeler (in Sanderson, 1980) estimated the total kill of mourning doves in 1972 at about 50 million birds, the great majority of this being from the U.S. Canadian birds are subject to hunting in the U.S. as they migrate to wintering areas. Breeding doves from the southern U.S. are essentially non-migratory. In the U.S. there is a call count survey, which is used to monitor the breeding population of doves, but this survey is not carried out in Canada.

Tree Swallow

Tree swallows are often caught in bad spring weather, causing substantial losses in potential breeding birds. Annual local population changes are expected, therefore, even when there is no long-term trend over a large area.

All swallows increase their activity during the day, as insect activity increases. Many swallows are counted on later BBS stops, as numbers of them fly over fields or water bodies, feeding on insects. In such conditions it is difficult to establish exact counts, and to ensure that young birds are not counted with the adults. Observational difficulties such as these increase the variability of results. These comments are most relevant to the tree swallow, and the barn swallow.

Cliff Swallow

Cliff Swallows are colonial nesters, so the difficulty of estimating large numbers of birds at a nesting site adds to the complications already mentioned for Tree Swallows.

Black-billed Magpie

Both the magpie and the American crow are predators of bird eggs. With the decline of duck breeding habitat that resulted from dry prairie conditions during the study period, these predators could have been supposed to prosper (because they could find duck eggs more easily in the poor nesting cover) or suffered (because of decreased supply of food from a variety of sources). We see from this survey that both egg predators declined in numbers.

American Crow

BBS observers have a special problem with the American crow, in trying to avoid counting the same individual from more than one stop. In open country the call of the crow can easily be heard for more than 1/4 mile, and crows may move in and out of the counting zone during the 3 minute stop.

Red-Winged Blackbird

Increases in the red-winged blackbird population were estimated for the Maritime Provinces, Central Ontario and Quebec, Southern Ontario and Quebec and Southern British Columbia with the increases for the Maritime Provinces and Southern Ontario and Quebec being significant. In the analyses of subperiods there was an increasing trend for the initial portion of the survey followed by a declining trend for all regions analyzed except Southern British Columbia. The estimated increase at the start of the survey was significant for all these regions for at least one of the two definitions of the initial period while the decline was significant for at least one of the definitions of the final period of the survey for all regions except Southern Ontario and Quebec. The increase in the initial period agrees with the conclusions of Erskine (1978) who attributed the increase in red-winged blackbirds to the increase in corn acreage. The upward trend appears to have reversed itself.

3.3) Trend analysis by region

Maritime Provinces - route regression analysis

The estimated trend for the period 1966-1983 was downward for 24 species and upward for the other 19 species analyzed. In the period from 1966-83 a significant increase in population was found for 11 species while a significant decline occurred for 16. Of those 11 species with a significant increase for 1966-83, the trend was upward in all subperiods analyzed for 5 species: Yellow Warbler, Tree Swallow, American Redstart, Veery and Ovenbird. Of the 16 species with a significant decline for 1966-83, the trend was downward in all subperiods analyzed for 7 species: Common Grackle, Least Flycatcher, White-Throated Sparrow, Brown-Headed

Cowbird, Yellow-Bellied Sapsucker, European Starling and House Sparrow.

Central Ontario and Quebec - route regression analysis

The estimated trend for the period 1967-1983 was downward for 30 species and upward for the other 13 species analyzed. The downward trends were significant for 10 species while the upward trends were significant for 5. For those species which had a significant upward trend for the period 1967-1983 the trend was upward in all subperiods analyzed for one species, Bobolink. A downward trend was detected for all subperiods analyzed for 5 species: European Starling, Song Sparrow, Common Yellowthroat, House Sparrow and Hermit Thrush.

Southern Ontario and Quebec - route regression analysis

The estimated trend for the period 1967-1983 was upward for 21 species and downward for 19 species. The increases were significant for 12 species and the declines were significant for 12 species. For two species: Ring-Billed Gull and Cedar Waxwing the estimated trend was upward for all subperiods examined. The trend was downward in all subperiods examined for 5 species: Yellow-shafted Flicker, Vesper Sparrow, Savannah Sparrow, Bank Swallow and Veery.

Southern Prairie Provinces - route regression analysis

The estimated trend for the period 1968-1983 was upward for 18 species and downward for 19 species. The upward trends were significant for 3 species and the downward ones for 6 species. A consistent decreasing trend over all subperiods analyzed with at least one being significant was found for 4 species: Franklin's Gull, Northern Pintail, American Coot and Lark Bunting.

Central Prairie Provinces - route regression analysis

The estimated trends for the period 1968-1983 were upward for 16 species and downward for 24 species. The increases were significant for 4 species and the declines were significant for 10 species. For one species, Barn Swallow, there was an upward trend, with at least one being significant, for all subperiods analyzed. There was a downward trend for all subperiods analyzed with at least one being significant for 5 species: Black Tern, American Crow, Pine Siskin, Clay-coloured Sparrow and Yellow Warbler.

Southern British Columbia - route regression analysis

For the period 1968-1983, an increasing trend was calculated for 17 species and a decreasing trend for 20 species. Four of these increasing trends were significant and 5 of the decreasing trends were significant. For 3 species (American Crow, Tree Swallow, and Winter Wren), the estimated trend was positive for all subperiods analyzed and significant for at least one subperiod. For 6 species (Western Wood Peewee, Western Meadowlark, Brewer's Blackbird, Pine Siskin, Chipping Sparrow and Yellow Warbler), the trend was negative for all subperiods analyzed and significant for at least one subperiod.

Comparison of regions - mean birds per route

Not all species provide enough data for analysis by the route regression method. In Appendix A the results from all species included in the BBS are summarized using the mean number of birds detected per route in two time periods. In that appendix a rough index is described that can be used to compare change among species. Selecting only those species that have an absolute value of the index greater than 0.1, and excluding all species that were not observed in both time periods, the sets were obtained whose counts are shown in Figure 3.

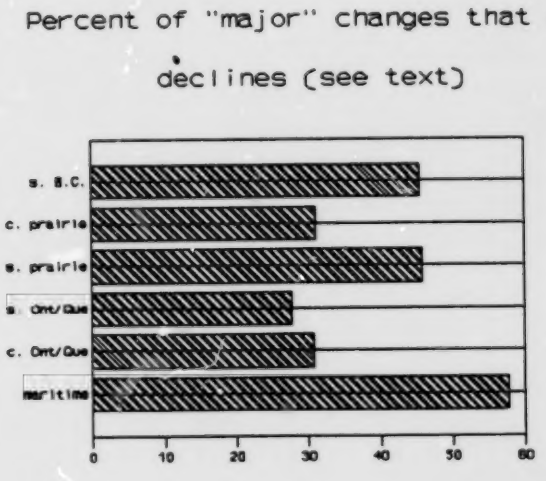

Figure 3

4) DISCUSSION

4.1) Observer Comparability

In the early analysis of year-to-year changes in breeding populations a careful matching of observations was made between years to ensure comparability in terms of observers and timing both in day of the year and starting and completion times (Erskine, 1978). In the more recent analysis of the BBS (Robbins et al., 1986) matching for observer effects and timing was not done. It was felt by those authors that the effects of observer changes were random and would not bias the results (Faanes and Bystrak, 1981). The switching of observers from year to year on the same route would increase the variance of the results but this was more than compensated for by the increase in sample size which resulted by not discarding the non-matching observer data. Faanes and Bystrak concluded the most effective manner of improving the precision of the analysis using the observer information would be to discard underqualified observers when they can be detected.

In the analysis done here, an observer effect was included in the model which adjusted the transformed data prior to the trend analysis. It was found that observer effects were often confounded with route effects and the number of degrees of freedom used to estimate observer effects was often substantially smaller than the number of observers included in the analysis (Table 4.1). Thus our efforts to adjust the results to what would be recorded by an average observer were not completely effective.

4.2) Starting time and survey date comparability

The design of the BBS brackets dawn when singing activity of many species is near its highest. Examination of the BBS data reveals that the pattern of activity varies greatly within the four to five hour period of the BBS data collection (Robbins, 1981). In addition, bird counts vary appreciably from week to week throughout the breeding season (Skirven, 1981). In previous Canadian analyses of these data, routes lost comparability points for the year to year comparisons if the starting time differed by more than 10 minutes or were more than 4 calendar days apart and were disqualified if starting times differed by more than 20 minutes or calendar day by more than 20 days (Erskine, 1978). In more recent analysis of BBS data no discarding of routes due to early or late starts or differences in calendar days were made (Robbins et al., 1986).

In the analysis reported here routes were divided into sub-routes which had starting times within a 20 minute time span or which differed by less than 14 calendar days. The relative advantage of increasing the precision of the data by reducing the

variability in admissible starting times and dates compared to the loss in precision incurred by reducing the number of admissible data points is unknown. Some BBS runs have taken place 40 minutes after their required starting times and some routes have been run as much as 5 weeks apart in time in different years. Such departures from instructions can have substantial influence on the counts.

The finishing time and duration of the survey were not used in establishing comparability of the routes as was done in other analyses (Erskine, 1978).

4.3) The need to increase BBS participation.

The BBS has some apparent deficiencies that are compensated for by the route regression technique. Unfortunately the technique is too elaborate for hand calculation. This fact may make it difficult for a volunteer to see how a days observations play a crucial part in the indices. Still, the success of the BBS depends entirely on expert volunteer participation. We hope that the publication of these results will help encourage people to give some time to the BBS effort so that subsequent analysis will be even more able to distinguish changes in bird populations.

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Appendix A - Summary of survey results for all species, without full statistical analysis

It was not possible to carry out the full statistical analysis of all species in all regions, because of insufficient data. Still, we realise that readers of this report will want to see what the BBS has available as indices for the less commonly counted species as well as those for which trend analysis was possible. This appendix has been provided to show simple indices of abundance in two time periods for all species that were counted by BBS observers.

The mean number of birds observed per route could be used as a density index. This would be misleading, however, for a species that does not have uniform densities across an analysis region. Suppose that a species is found only in the eastern half of a region. Then, even with no real change in density the addition of new routes in the western part of the region would cause an apparent drop in the index. To avoid this problem, a route was used to calculate the index for a species only if the species was recorded on it at least once through the 16 year period. That route was then included every time it was rerun in each subperiod whether the species was recorded on it or not. To allow an assessment of population change, indices have been calculated for two time periods, i.e., 1966-1977 and 1978-1983. These time periods were chosen after the trend analysis of this study indicated that several species showed a change in trend roughly corresponding to these periods.

In many places in this appendix the number of routes for one time period is zero. This means that none of the routes for which we have data on this species were included in that time period. In this case the index for the time period with no routes included is always shown as n.d. (not defined).

It is not appropriate to compare densities of two different species using this table because the geographic range of sample routes used, the effective distance of detection, and seasonal and time of day effects vary from species to species.

By restricting the calculation of indices to those routes that ever recorded the species, the effect of changing routes and observers is reduced somewhat. This analysis is not a match for the proper trend analysis used in this study for the better data sets, in which trends were calculated for individual routes. Species for which trend analysis has been done are indicated with asterisks (*) in the table.

In some cases an apparent change in the index actually refers to a change in BBS technique. For example, the indices in the Maritime provinces show a decrease in Traill's Flycatchers but this is not a real decrease but an increased tendency for

observers to discriminate between Alder and Willow Flycatchers, which make up the Traill's Flycatcher complex.

Some species are represented at only one or two routes in a region. For example the Cattle Egret in the Maritime provinces was seen only once in the first time period, and not at all in the second, on a route that was done 15 times. The reader should not infer a change in population from samples this small. We have left some such results in this table to provide a more complete review of BBS results, while realizing that they may be misleading to the casual reader.

Although the BBS is intended to count breeding birds only, it does happen that late migrants and other out of place birds are observed. This report should not be taken as evidence of breeding status for birds that are unusual in a region.

The tables in this appendix were derived from computer files that have been edited but may still contain occasional coding errors, and observer identification errors. In preparing this report we have removed some of the most questionable reports (such as California Gull from the Maritime provinces), but have left others. The reader is advised again not to draw conclusions on species distribution when only small samples are available.

The number of potential routes shown in the tables is not generally the same for the two time periods. This is primarily because the first period covers up to 12 years, while the second covers only 6 years. In the settled parts of the country the continuity of observation has been sufficient to allow calculation of reasonable indices for both periods. But in Labrador, Northern B.C. and the Yukon, and in Newfoundland, the enthusiasm for this survey seems to have diminished so that the second time period is not useful for population monitoring. These regions have been left in the tables to point out a basic fact of the BBS - that continued replication of routes is necessary to provide useful results. This is especially important in inaccessible areas where so much effort is demanded of the observer.

Because the technique used to make the tables in this appendix ignores the within-route trends the results are different from those obtained from the better approach. Here is a comparison of the number of significant results from the 1966-83 time period in the route regression analysis with the indices presented in this appendix.

Region	Significant Results 1966-83	Sign of change Agrees
Maritime Provinces	27	24
Central Ontario and Quebec	15	13
Southern Ontario and Quebec	24	22
Southern Prairie Region	9	9
Central Prairie Region	14	10
Southern British Columbia	9	8
Total	98	86

This appendix is provided primarily for completeness. The importance of the observer and that of the route to BBS results are so great that we are reluctant to suggest that the means in Appendix A are representative of the broad regions from which they are taken. In fact, something equivalent to the route regression method used in this report is needed to produce reliable trends from the BBS. Still, one reviewer of an earlier draft of this paper asked whether an index could be calculated from the sample sizes and means to allow comparison among species.

Perhaps the most natural index of change that could be presented in this appendix would be the t-statistic for the difference of means between the two time periods. We purposefully avoided the calculation of this statistic, because it invites a test of hypothesis that we feel is invalid. Using the numbers given in the tables it is possible to calculate an important part of the t-statistic, namely the variance estimate derived from means. Using the square root, with appropriate sign:

$$\text{index} = \frac{\bar{Y}_1 - \bar{Y}_2}{(n_1+n_2)/n_1n_2} \quad .$$

In an analysis of variance table to compare the two means, this would be the square root of the mean square coming from the difference between the means for the two time periods. For testing of hypotheses, the variance estimate from individuals would be required. We have not calculated this statistic, however

if it is assumed that the variance is constant among the different bird species, the index shown above can be used as a rough indication of change.

In the tables below, for the 6 major regions, this index was used to mark the species with the strongest indication of change. First all species without observations in both time periods were excluded. So were declines in Traill's Flycatchers with a concomitant increase in Alder or Willow Flycatcher. An arbitrary value of 0.2 was chosen to define significant index values. Those with an increase over the two time periods were marked I and those with a decrease were marked D. The reader whose eye has been drawn to one species in the table because of a D or I marking should ensure that the sample sizes, range of the bird, and lack of confusion of nomenclature justify the interpretation of change.

The order of species in these tables is taken from Godfrey (1986).

Table A1. Summary of BBS indices for Maritime Provinces.

Species	Potential Routes 66-77	Potential Routes 78-83	Index 66-77	Index 78-83	
Common Loon	440	157	0.78	1.08	
Pied-billed Grebe	124	43	0.27	0.23	
Northern Gannet	9	3	1.44	0.00	
Great Cormorant	8	1	0.63	0.00	
Double-crested Cormorant	256	100	8.59	15.46	I
American Bittern	477	173	0.87	0.65	
Great Blue Heron	441	161	2.38	2.06	
Cattle Egret	10	5	0.10	0.00	
Green-backed Heron	30	11	0.07	0.09	
Black-crowned Night Heron	47	12	0.49	0.25	
Canada Goose	64	28	0.30	0.29	
Wood Duck	74	25	0.49	0.64	
Green-winged Teal	130	50	0.25	0.20	
American Black Duck	450	162	1.47	0.81	
Mallard	42	19	0.19	0.53	
Northern Pintail	52	22	0.15	0.05	
Blue-winged Teal	125	43	0.91	0.72	
American Wigeon	65	27	0.40	0.67	
Ring-necked Duck	126	46	1.06	0.26	
Common Eider	72	30	5.17	3.03	D
Common Goldeneye	50	21	0.56	0.29	
Hooded Merganser	19	6	0.05	0.17	
Common Merganser	264	85	0.29	0.40	
Red-breasted Merganser	89	31	0.42	0.32	
Osprey	309	114	0.42	0.54	
Bald Eagle	91	37	0.22	0.16	
Northern Harrier	322	112	0.17	0.38	
Sharp-shinned Hawk	110	32	0.15	0.03	
Cooper's Hawk	24	3	0.04	0.33	
Northern Goshawk	109	34	0.11	0.18	
Red-shouldered Hawk	18	8	0.06	0.25	
Broad-winged Hawk	178	61	0.12	0.08	
Red-tailed Hawk	200	81	0.20	0.20	
Rough-Legged Hawk	12	4	0.08	0.00	
Unidentified Buteo	19	6	0.05	0.17	
American Kestrel	404	140	0.34	0.40	
Merlin	89	33	0.10	0.06	
Peregrine Falcon	11	5	0.18	0.00	
Gray Partridge	11	4	0.18	0.00	
Ring-necked Pheasant	178	67	1.49	3.21	
Spruce Grouse	34	15	0.09	0.07	
Ruffed Grouse	408	152	0.51	0.26	
Virginia Rail	34	13	0.06	0.08	
Sora	118	45	0.22	0.13	
Black-bellied Plover	24	6	0.46	0.00	
Semipalmated Plover	42	15	0.19	0.00	

Table A1. Summary of BBS indices for Maritime Provinces.

Species	Potential Routes		Index		
	66-77	78-83	66-77	78-83	
Killdeer	409	150	1.84	2.35	
Greater Yellowlegs	70	24	0.40	0.13	
Lesser Yellowlegs	22	10	0.00	0.20	
Willet	92	43	6.78	6.95	
Spotted Sandpiper	483	175	0.96	0.94	
Upland Sandpiper	40	16	0.08	0.06	
Semipalmated Sandpiper	7	5	5.00	0.00	
Least Sandpiper	43	20	0.14	0.15	
Pectoral Sandpiper	12	5	0.00	0.20	
Short-Billed Dowitcher	12	5	0.00	1.00	
Common Snipe	508	186	5.44	3.98	
American Woodcock	248	82	0.40	0.12	
Bonaparte's Gull	10	5	0.30	0.00	
Ring-billed Gull	68	23	0.62	3.61	I
Herring Gull	424	149	29.81	30.74	
Glaucous Gull	7	5	0.14	0.00	
Great Black-backed Gull	413	152	7.50	7.84	
Common Tern	200	68	3.43	1.91	
Arctic Tern	29	9	0.14	0.00	
Black Tern	32	14	1.16	0.21	D
Black Guillemot	15	1	0.27	0.00	
Rock Dove	369	142	3.52	6.77	I
Mourning Dove	238	94	0.24	0.52	
Black-billed Cuckoo	315	120	0.76	0.73	
Great Horned Owl	117	48	0.12	0.25	
Barred Owl	176	70	0.11	0.29	
Great Gray Owl	6	5	0.00	0.20	
Long-eared Owl	5	4	0.00	1.25	
Short-eared Owl	12	4	0.08	0.00	
Boreal Owl	11	5	0.00	0.20	
Northern Saw-whet Owl	54	18	0.17	0.06	
Common Nighthawk	325	128	0.60	0.67	
Whip-Poor-Will	54	22	0.33	0.50	
Chimney Swift	468	165	2.82	1.08	
Ruby-throated Hummingbird	442	157	0.47	0.38	
Belted Kingfisher	481	171	0.82	0.74	
Yellow-bellied Sapsucker	472	172	7.62	3.29	D
Downy Woodpecker	476	165	0.61	1.03	
Hairy Woodpecker	493	176	0.69	0.86	
Three-toed Woodpecker	18	7	0.06	0.43	
Black-backed Woodpecker	152	63	0.11	0.32	
Yellow-shafted Flicker	513	187	3.45	2.66	
Pileated Woodpecker	237	94	0.24	0.40	
Olive-sided Flycatcher	506	181	1.98	1.27	
Eastern Wood-Pewee	513	184	2.13	2.35	
Yellow-bellied Flycatcher	464	165	2.80	1.98	
Alder Flycatcher	500	187	6.48	14.75	

Table A1. Summary of BBS indices for Maritime Provinces.

Species	Potential Routes		Index		
	66-77	78-83	66-77	78-83	
Willow Flycatcher	12	4	0.00	0.25	
Traill's Flycatcher Complex	512	179	8.72	0.53	
Least Flycatcher	505	182	5.32	4.20	
Unidentified Empidonax Sp.	44	17	0.25	0.00	
Eastern Phoebe	338	129	0.88	0.98	
Great Crested Flycatcher	183	75	0.17	0.19	
Eastern Kingbird	479	180	1.20	1.09	
Horned Lark	181	63	0.96	0.49	
Purple Martin	121	46	2.89	3.46	
Tree Swallow	513	187	15.37	14.98	
Northern Rough-winged Swallow	9	1	0.11	0.00	
Bank Swallow	503	181	17.67	15.46	
Cliff Swallow	444	166	4.43	4.77	
Barn Swallow	513	187	22.37	21.86	
Gray Jay	460	164	1.14	0.79	
Blue Jay	513	186	4.51	4.22	
American Crow	513	187	35.56	40.39	I
Common Raven	513	187	9.54	10.70	
Black-capped Chickadee	500	181	3.08	3.73	
Boreal Chickadee	480	171	2.01	0.82	
Red-breasted Nuthatch	480	172	0.97	0.76	
White-breasted Nuthatch	192	71	0.29	0.25	
Brown Creeper	145	50	0.12	0.06	
House Wren	36	13	0.11	0.08	
Winter Wren	466	166	4.94	1.67	D
Golden-crowned Kinglet	407	142	0.56	0.68	
Ruby-crowned Kinglet	513	186	14.52	6.55	D
Eastern Bluebird	44	12	0.16	0.00	
Veery	447	165	9.66	12.12	
Gray-cheeked Thrush	63	19	0.44	0.32	
Swainson's Thrush	513	187	19.01	15.61	D
Hermit Thrush	508	187	8.15	8.48	
Wood Thrush	237	90	2.11	2.27	
American Robin	513	187	65.65	53.68	D
Gray Catbird	482	179	3.06	3.91	
Northern Mockingbird	72	23	0.10	0.09	
Brown Thrasher	76	32	0.18	0.06	
Water Pipit	9	2	0.11	0.00	
Cedar Waxwing	462	179	3.07	5.32	
Loggerhead Shrike	12	5	0.08	0.00	
European Starling	508	187	47.75	41.81	D
Solitary Vireo	494	175	2.06	2.97	
Warbling Vireo	88	36	0.07	0.28	
Philadelphia Vireo	74	30	1.26	0.33	
Red-eyed Vireo	513	187	13.16	19.14	I
Tennessee Warbler	513	186	6.37	6.31	
Nashville Warbler	508	187	5.63	4.31	

Table A1. Summary of BBS indices for Maritime Provinces.

Species	Potential Routes		Index		
	66-77	78-83	66-77	78-83	
Northern Parula	513	184	4.31	6.73	
Yellow Warbler	513	186	10.84	13.02	
Chestnut-sided Warbler	496	184	6.54	5.68	
Magnolia Warbler	513	186	14.58	14.77	
Cape May Warbler	405	152	1.23	1.16	
Black-throated Blue Warbler	407	139	0.60	0.68	
Yellow-rumped Warbler	513	187	4.03	5.66	
Black-throated Green Warbler	513	185	5.73	5.92	
Blackburnian Warbler	469	173	1.15	1.76	
Pine Warbler	33	14	0.12	0.00	
Palm Warbler	243	84	1.18	1.44	
Bay-breasted Warbler	467	168	2.54	2.46	
Blackpoll Warbler	361	126	1.86	0.94	
Black-and-white Warbler	513	187	3.23	5.44	
American Redstart	513	187	17.06	22.74	
Ovenbird	508	187	12.46	15.51	
Northern Waterthrush	458	163	2.69	3.11	
Mourning Warbler	433	154	3.30	3.44	
Common Yellowthroat	513	187	23.18	24.73	
Wilson's Warbler	376	141	0.92	1.40	
Canada Warbler	487	175	2.88	3.66	
Yellow-breasted Chat	33	10	0.12	0.00	
Scarlet Tanager	201	76	0.26	0.49	
Rose-breasted Grosbeak	469	175	3.54	7.99	I
Indigo Bunting	70	31	0.11	0.03	
Rufous-sided Towhee	16	7	0.13	0.00	
Chipping Sparrow	513	187	8.94	9.89	
Field Sparrow	50	20	0.04	0.15	
Vesper Sparrow	225	78	0.90	0.90	
Savannah Sparrow	487	181	15.25	9.72	D
Sharp-tailed Sparrow	151	64	1.09	0.58	
Fox Sparrow	90	31	3.16	1.81	D
Song Sparrow	513	187	34.94	28.45	D
Lincoln's Sparrow	409	141	3.08	2.95	
Swamp Sparrow	500	177	2.07	1.62	
White-throated Sparrow	513	187	55.16	34.49	D
White-crowned Sparrow	12	3	0.00	9.00	
Slate-coloured Junco	513	186	13.98	9.66	D
Bobolink	480	181	17.17	26.90	I
Red-winged Blackbird	513	187	21.78	19.74	
Eastern Meadowlark	189	64	0.25	0.13	
Rusty Blackbird	416	142	1.00	0.54	
Common Grackle	513	186	32.17	19.81	D
Brown-headed Cowbird	513	186	8.46	4.55	D
Baltimore Oriole	203	78	0.27	0.45	
Pine Grosbeak	287	100	1.24	0.49	
Purple Finch	513	187	8.81	6.02	

Table A1. Summary of BBS indices for Maritime Provinces.

Species	Potential Routes		Index		
	66-77	78-83	66-77	78-83	
Red Crossbill	260	101	0.81	0.17	
White-winged Crossbill	220	80	1.15	0.63	
Pine Siskin	464	166	3.51	2.31	
American Goldfinch	513	187	13.60	9.05	D
Evening Grosbeak	427	154	21.83	8.25	D
House Sparrow	487	181	18.17	14.99	D

Table A2. Summary of BBS indices for Central Ontario and Quebec.

Species	Potential Routes		Index		
	66-77	78-83	66-77	78-83	
Common Loon	362	262	1.87	2.08	
Pied-billed Grebe	122	62	0.27	0.15	
Red-necked Grebe	20	12	0.30	0.25	
American White Pelican	8	5	0.00	0.60	
Double-crested Cormorant	17	25	6.53	36.28	I
American Bittern	366	238	0.78	0.82	
Least Bittern	9	5	0.11	0.00	
Great Blue Heron	361	239	1.13	1.28	
Green-backed Heron	68	43	0.18	0.09	
Black-crowned Night Heron	55	36	0.36	0.92	
Tundra Swan	10	5	0.00	0.20	
Canada Goose	43	32	0.67	1.50	
Wood Duck	103	63	0.31	0.24	
Green-winged Teal	57	39	1.56	2.13	
American Black Duck	300	183	0.85	0.92	
Mallard	243	148	1.18	2.24	
Northern Pintail	30	25	0.57	1.68	
Blue-winged Teal	154	85	0.51	1.22	
Northern Shoveler	10	5	0.00	0.60	
American Wigeon	29	12	0.10	0.17	
Ring-necked Duck	99	62	0.63	0.40	
Greater Scaup	6	7	3.33	5.86	I
Lesser Scaup	39	11	0.15	0.73	
Unidentified Scaup	10	5	0.00	0.20	
Common Eider	7	14	176.14	198.93	I
King Eider	0	3	n.d.	53.33	
Oldsquaw	10	1	0.50	0.00	
Surf Scoter	4	8	0.00	1.63	
White-winged Scoter	4	5	0.00	48.00	
Common Goldeneye	188	130	0.52	0.57	
Barrow's Goldeneye	8	3	0.38	0.00	
Bufflehead	6	4	0.17	0.00	
Hooded Merganser	95	45	0.47	0.31	
Common Merganser	239	157	0.39	0.59	
Red-breasted Merganser	34	20	0.71	0.15	
Ruddy Duck	10	5	0.00	0.20	
Turkey Vulture	51	23	0.08	0.96	
Osprey	99	92	0.19	0.34	
Bald Eagle	20	11	0.10	0.18	
Northern Harrier	183	127	0.23	0.44	
Sharp-shinned Hawk	86	57	0.12	0.19	
Cooper's Hawk	23	10	0.22	0.00	
Northern Goshawk	39	20	0.08	0.25	
Red-shouldered Hawk	64	36	0.13	0.11	
Broad-winged Hawk	331	204	0.41	0.52	
Red-tailed Hawk	152	108	0.12	0.28	

Table A2. Summary of BBS indices for Central Ontario and Quebec.

Species	Potential Routes		Index		
	66-77	78-83	66-77	78-83	
Unidentified Buteo	8	3	0.63	0.00	
American Kestrel	378	247	0.91	1.08	
Merlin	95	51	0.12	0.20	
Peregrine Falcon	9	0	0.11	n.d.	
Gyrfalcon	4	5	0.00	0.20	
Ring-necked Pheasant	7	5	0.00	0.20	
Spruce Grouse	29	21	0.21	0.10	
Ruffed Grouse	291	197	0.63	0.68	
Yellow Rail	15	4	0.13	0.00	
Virginia Rail	39	24	0.10	0.17	
Sora	96	54	0.28	0.24	
American Coot	20	9	0.05	0.33	
Sandhill Crane	0	3	n.d.	2.00	
Semipalmated Plover	2	2	0.00	0.50	
Piping Plover	2	2	2.50	1.50	D
Killdeer	393	265	5.31	5.49	
Lesser Yellowlegs	17	8	0.18	0.00	
Solitary Sandpiper	60	38	0.28	0.16	
Spotted Sandpiper	347	228	0.78	0.84	
Upland Sandpiper	101	60	0.46	0.98	
Least Sandpiper	12	7	0.25	0.00	
Short-Billed Dowitcher	4	5	0.00	43.00	
Common Snipe	377	263	2.48	3.20	
American Woodcock	140	71	0.51	0.59	
Wilson's Phalarope	1	3	2.00	0.00	
Bonaparte's Gull	21	14	0.33	0.50	
Ring-billed Gull	187	109	11.67	42.53	I
Herring Gull	345	241	10.55	23.63	I
Great Black-backed Gull	31	36	4.94	18.11	I
Unidentified Gull	10	5	0.60	0.00	
Caspian Tern	28	20	0.43	0.65	
Common Tern	109	59	2.49	5.31	I
Black Tern	61	31	1.80	1.23	
Black Guillemot	4	8	0.00	0.75	
Rock Dove	220	151	1.66	2.60	
Mourning Dove	279	181	0.78	1.03	
Black-billed Cuckoo	302	193	1.95	2.26	
Yellow-billed Cuckoo	106	54	0.22	0.11	
Common Barn Owl	10	5	0.10	0.00	
Eastern Screech-Owl	6	4	0.17	0.00	
Great Horned Owl	95	48	0.19	0.06	
Barred Owl	80	55	0.08	0.25	
Great Gray Owl	23	22	0.09	0.27	
Short-eared Owl	36	20	0.08	0.10	
Northern Saw-whet Owl	5	5	0.20	0.00	
Common Nighthawk	249	152	0.65	0.66	
Whip-Poor-Will	112	69	0.28	0.46	

Table A2. Summary of BBS indices for Central Ontario and Quebec.

Species	Potential Routes		Index	
	66-77	78-83	66-77	78-83
Chimney Swift	233	161	1.65	1.39
Ruby-throated Hummingbird	279	178	0.38	0.24
Belted Kingfisher	401	291	1.16	0.88
Red-headed Woodpecker	36	21	0.36	0.52
Yellow-bellied Sapsucker	381	255	3.24	2.35
Downy Woodpecker	349	244	0.77	0.91
Hairy Woodpecker	343	231	0.89	0.85
Three-toed Woodpecker	6	5	0.00	0.20
Black-backed Woodpecker	103	81	0.16	0.37
Yellow-shafted Flicker	422	295	4.09	3.19
Pileated Woodpecker	271	194	0.41	0.94
Olive-sided Flycatcher	367	268	1.03	1.30
Eastern Wood-Pewee	293	215	1.60	1.57
Yellow-bellied Flycatcher	181	135	0.83	1.07
Alder Flycatcher	384	293	4.26	7.91
Willow Flycatcher	46	22	0.39	1.27
Traill's Flycatcher Complex	354	190	4.59	0.03
Least Flycatcher	419	301	8.45	7.33
Eastern Phoebe	285	173	2.12	1.67
Great Crested Flycatcher	215	140	2.67	3.75
Eastern Kingbird	332	244	2.35	3.37
Horned Lark	145	89	1.70	0.89
Purple Martin	105	65	0.75	1.43
Tree Swallow	422	301	11.41	13.38
Northern Rough-winged Swallow	145	87	0.46	0.71
Bank Swallow	352	242	10.49	12.89
Cliff Swallow	345	222	6.85	8.28
Barn Swallow	415	289	13.97	15.07
Gray Jay	270	187	1.66	1.26
Blue Jay	390	276	4.23	3.38
American Crow	421	302	26.05	26.70
Common Raven	406	302	5.54	8.01
Black-capped Chickadee	415	287	2.67	3.35
Boreal Chickadee	200	167	0.49	0.65
Red-breasted Nuthatch	409	270	1.65	1.28
White-breasted Nuthatch	198	116	0.61	0.82
Brown Creeper	121	86	0.29	0.33
House Wren	216	141	1.05	1.01
Winter Wren	409	292	6.57	4.10
Sedge Wren	93	59	0.72	0.92
Marsh Wren	30	18	0.07	0.11
Golden-crowned Kinglet	213	151	0.98	0.99
Ruby-crowned Kinglet	411	293	6.72	5.03
Eastern Bluebird	143	71	0.50	0.24
Veery	389	283	21.75	20.06
Gray-cheeked Thrush	16	18	1.56	1.06
Swainson's Thrush	421	300	13.78	19.74

Table A2. Summary of BBS indices for Central Ontario and Quebec.

Species	Potential Routes 66-77	Potential Routes 78-83	Index 66-77	Index 78-83	
Hermit Thrush	419	290	8.01	4.90	
Wood Thrush	220	155	5.55	5.00	
American Robin	422	303	31.10	36.77	I
Varied Thrush	0	3	n.d.	0.33	
Gray Catbird	298	206	2.50	1.86	
Northern Mockingbird	94	47	0.13	0.11	
Brown Thrasher	268	167	2.31	1.99	
Bohemian Waxwing	4	0	0.50	n.d.	
Cedar Waxwing	417	298	3.51	8.83	
Northern Shrike	9	1	0.11	0.00	
Loggerhead Shrike	40	19	0.20	0.00	
European Starling	411	282	48.20	33.76	D
White-eyed Vireo	4	0	0.25	n.d.	
Solitary Vireo	332	232	1.29	1.42	
Yellow-throated Vireo	62	29	0.35	0.03	
Warbling Vireo	204	150	0.68	1.10	
Philadelphia Vireo	264	197	1.52	1.36	
Red-eyed Vireo	420	294	29.44	27.89	
Golden-winged Warbler	69	37	0.19	0.16	
Tennessee Warbler	349	260	4.07	10.77	I
Orange-crowned Warbler	22	15	0.23	0.60	
Nashville Warbler	416	298	10.07	10.17	
Northern Parula	205	185	0.42	0.63	
Yellow Warbler	395	284	4.42	4.45	
Chestnut-sided Warbler	412	296	16.29	13.65	
Magnolia Warbler	419	297	5.19	5.63	
Cape May Warbler	287	220	0.77	1.48	
Black-throated Blue Warbler	291	214	0.83	0.77	
Yellow-rumped Warbler	412	296	4.60	6.02	
Black-throated Green Warbler	346	266	2.15	2.43	
Blackburnian Warbler	346	248	1.80	1.72	
Pine Warbler	146	81	0.51	0.63	
Prairie Warbler	9	0	0.11	n.d.	
Palm Warbler	69	51	0.19	0.27	
Bay-breasted Warbler	314	233	1.33	2.58	
Blackpoll Warbler	123	98	4.29	9.40	I
Cerulean Warbler	8	5	0.25	0.00	
Black-and-white Warbler	388	280	3.19	3.10	
American Redstart	416	299	7.10	8.94	
Ovenbird	418	293	19.71	20.18	
Northern Waterthrush	400	276	1.60	2.27	
Connecticut Warbler	122	75	1.84	0.93	
Mourning Warbler	416	289	9.30	9.39	
Common Yellowthroat	420	303	16.26	14.52	
Wilson's Warbler	221	164	1.28	1.36	
Canada Warbler	381	275	2.58	2.32	
Scarlet Tanager	287	201	1.44	1.29	

Table A2. Summary of BBS indices for Central Ontario and Quebec.

Species	Potential Routes		Index		
	66-77	78-83	66-77	78-83	
Northern Cardinal	16	10	0.13	0.00	
Rose-breasted Grosbeak	377	269	5.94	7.76	
Indigo Bunting	231	142	3.11	2.33	
Rufous-sided Towhee	112	79	0.65	0.35	
American Tree Sparrow	3	2	0.00	2.00	
Chipping Sparrow	421	302	13.21	14.66	
Clay-coloured Sparrow	98	63	1.48	0.94	
Field Sparrow	128	77	0.76	0.39	
Vesper Sparrow	307	187	2.01	1.60	
Savannah Sparrow	382	246	17.61	17.33	
Grasshopper Sparrow	67	36	0.19	0.47	
Le Conte's Sparrow	37	16	0.49	0.25	
Sharp-tailed Sparrow	1	3	0.00	0.67	
Fox Sparrow	36	56	1.25	4.13	I
Song Sparrow	419	297	21.24	15.46	D
Lincoln's Sparrow	264	184	4.83	5.27	
Swamp Sparrow	411	274	3.21	2.34	
White-throated Sparrow	422	302	49.15	44.32	D
White-crowned Sparrow	16	9	0.19	7.89	I
Slate-coloured Junco	390	279	4.57	4.82	
Bobolink	311	213	15.70	22.28	I
Red-winged Blackbird	417	295	21.41	26.53	I
Eastern Meadowlark	204	133	4.13	3.32	
Western Meadowlark	93	48	2.19	2.19	
Yellow-headed Blackbird	10	7	0.20	0.57	
Rusty Blackbird	156	120	1.32	0.63	
Brewer's Blackbird	69	43	3.14	4.21	
Common Grackle	419	301	14.36	15.25	
Brown-headed Cowbird	401	278	9.30	7.27	
Baltimore Oriole	224	147	1.29	1.69	
Pine Grosbeak	80	67	0.48	0.99	
Purple Finch	420	296	3.33	4.45	
Red Crossbill	41	18	1.32	0.06	D
White-winged Crossbill	77	49	5.38	0.86	D
Common Redpoll	25	9	0.12	0.00	
Pine Siskin	292	202	4.79	4.11	
American Goldfinch	412	290	8.58	5.99	
Evening Grosbeak	397	287	8.27	12.29	
House Sparrow	318	207	14.45	9.54	D

Table A3. Summary of BBS indices for Southern Ontario and Quebec.

Species	Potential Routes 66-77	Potential Routes 78-83	Index 66-77	Index 78-83	
Common Loon	173	81	0.42	0.46	
Pied-billed Grebe	144	71	0.40	0.23	
Double-crested Cormorant	16	5	0.19	2.00	I
American Bittern	275	133	1.01	1.11	
Least Bittern	38	19	0.08	0.05	
Great Blue Heron	330	163	1.55	2.31	
Great Egret	10	5	1.30	0.60	D
Green-backed Heron	268	126	0.78	0.82	
Black-crowned Night-Heron	100	53	0.67	0.62	
Canada Goose	163	78	1.51	2.68	
Wood Duck	207	106	0.29	0.43	
Green-winged Teal	37	17	0.11	0.12	
American Black Duck	288	132	0.78	0.71	
Mallard	305	146	4.47	4.66	
Northern Pintail	50	27	0.70	0.22	
Blue-winged Teal	246	114	0.49	0.86	
Northern Shoveler	21	9	0.05	0.11	
Gadwall	10	4	0.30	0.00	
American Wigeon	21	9	0.38	1.67	I
Ring-necked Duck	10	0	0.10	n.d.	
Lesser Scaup	10	4	0.30	0.00	
Common Goldeneye	19	9	0.11	0.00	
Barrow's Goldeneye	7	5	0.00	0.20	
Bufflehead	10	5	0.10	0.00	
Hooded Merganser	18	10	0.00	0.40	
Common Merganser	38	20	0.11	0.85	
Red-breasted Merganser	9	5	0.00	0.20	
Unidentified Duck	34	15	0.00	0.20	
Turkey Vulture	122	66	0.39	0.97	
Osprey	36	20	0.08	0.15	
Bald Eagle	10	5	0.20	0.00	
Northern Harrier	314	162	0.50	0.61	
Sharp-shinned Hawk	84	42	0.10	0.14	
Cooper's Hawk	53	23	0.09	0.09	
Northern Goshawk	41	16	0.10	0.06	
Unidentified Accipiter	11	2	0.09	0.00	
Red-shouldered Hawk	154	76	0.15	0.16	
Broad-winged Hawk	145	68	0.10	0.32	
Red-tailed Hawk	275	132	1.03	1.00	
Unidentified Buteo	32	17	0.13	0.00	
American Kestrel	339	170	0.98	1.42	
Merlin	12	5	0.00	0.40	
Peregrine Falcon	22	10	0.14	0.00	
Gray Partridge	38	14	0.16	0.21	
Ring-necked Pheasant	207	106	2.34	1.44	
Ruffed Grouse	161	85	0.25	0.35	

Table A3. Summary of BBS indices for Southern Ontario and Quebec.

Species	Potential Routes		Index		
	66-77	78-83	66-77	78-83	
Northern Bobwhite	40	20	15.65	2.95	D
Virginia Rail	58	28	0.10	0.18	
Sora	97	42	0.15	0.07	
Common Moorhen	106	50	0.76	0.46	
American Coot	47	24	0.17	0.21	
Black-bellied Plover	11	5	0.27	0.00	
Semipalmated Plover	28	13	0.11	0.15	
Killdeer	352	176	18.06	18.29	
Solitary Sandpiper	6	5	0.00	0.20	
Spotted Sandpiper	350	176	1.39	1.33	
Upland Sandpiper	318	160	2.49	3.12	
Least Sandpiper	12	5	0.75	0.00	
Common Snipe	303	150	3.81	4.44	
American Woodcock	112	50	0.18	0.26	
Bonaparte's Gull	29	14	0.03	0.43	
Ring-billed Gull	274	141	13.99	40.82	I
Herring Gull	194	97	3.41	7.99	I
Great Black-backed Gull	16	6	0.06	0.83	I
Unidentified Gull	24	14	15.79	27.36	I
Caspian Tern	19	9	0.05	0.33	
Common Tern	57	27	3.88	1.41	D
Black Tern	127	54	1.09	0.76	
Rock Dove	352	176	16.66	20.50	I
Mourning Dove	352	176	13.81	18.39	I
Black-billed Cuckoo	332	165	1.24	1.38	
Yellow-billed Cuckoo	234	112	0.37	0.38	
Eastern Screech-Owl	10	4	0.00	0.25	
Great Horned Owl	222	107	0.20	0.27	
Barred Owl	24	14	0.08	0.07	
Short-eared Owl	9	5	0.11	0.00	
Common Nighthawk	60	28	0.75	0.71	
Whip-Poor-Will	118	55	0.58	0.47	
Chimney Swift	344	166	2.51	2.09	
Ruby-throated Hummingbird	252	127	0.19	0.22	
Belted Kingfisher	340	170	0.84	0.74	
Red-headed Woodpecker	158	87	0.79	0.75	
Red-bellied Woodpecker	29	15	0.07	0.53	
Yellow-bellied Sapsucker	223	106	0.62	0.56	
Downy Woodpecker	342	166	0.91	1.08	
Hairy Woodpecker	268	141	0.33	0.57	
Yellow-shafted Flicker	352	176	5.69	4.90	
Pileated Woodpecker	131	66	0.31	0.32	
Olive-sided Flycatcher	124	64	0.16	0.22	
Eastern Wood-Pewee	352	176	3.88	4.04	
Yellow-bellied Flycatcher	50	29	0.26	0.31	
Alder Flycatcher	317	157	1.00	2.83	
Willow Flycatcher	189	98	0.59	1.91	

Table A3. Summary of BBS indices for Southern Ontario and Quebec.

Species	Potential Routes 66-77	Potential Routes 78-83	Index 66-77	Index 78-83	
Traill's Flycatcher Complex	285	146	1.46	0.00	
Least Flycatcher	352	176	2.39	3.28	
Eastern Phoebe	350	171	2.57	1.73	
Great Crested Flycatcher	346	175	5.34	5.18	
Eastern Kingbird	352	176	8.39	11.22	
Horned Lark	352	176	5.94	7.00	
Purple Martin	289	140	5.88	5.97	
Tree Swallow	352	176	11.28	14.42	
Northern Rough-winged Swallow	305	150	1.18	1.64	
Bank Swallow	342	171	32.45	32.73	
Cliff Swallow	327	165	2.69	4.03	
Barn Swallow	352	176	36.23	42.22	I
Blue Jay	350	176	4.71	5.15	
American Crow	352	176	47.44	45.94	
Common Raven	32	15	0.56	1.67	I
Black-capped Chickadee	340	171	2.08	3.54	
Boreal Chickadee	13	6	0.08	0.17	
Red-breasted Nuthatch	172	95	0.48	0.35	
White-breasted Nuthatch	303	153	0.63	0.51	
Brown Creeper	106	52	0.13	0.19	
Carolina Wren	9	5	0.44	0.00	
House Wren	351	175	4.68	4.55	
Winter Wren	193	106	1.03	0.42	
Sedge Wren	117	53	0.16	0.09	
Marsh Wren	118	52	0.31	0.50	
Golden-crowned Kinglet	16	10	0.13	0.20	
Ruby-crowned Kinglet	102	55	0.75	0.84	
Blue-grey Gnatcatcher	19	10	0.05	0.10	
Eastern Bluebird	220	105	0.57	0.23	
Veery	333	166	5.65	6.33	
Swainson's Thrush	90	54	0.90	1.52	
Hermit Thrush	138	73	0.62	0.85	
Wood Thrush	344	175	3.13	2.90	
American Robin	352	176	52.61	53.52	
Gray Catbird	352	176	4.17	4.73	
Northern Mockingbird	121	59	0.14	0.29	
Brown Thrasher	340	170	5.22	3.85	
Cedar Waxwing	352	176	5.09	11.11	I
Loggerhead Shrike	157	65	0.38	0.15	
European Starling	352	176	176.29	134.93	D
White-eyed Vireo	0	5	n.d.	0.20	
Solitary Vireo	56	27	0.13	0.37	
Yellow-throated Vireo	174	82	0.25	0.28	
Warbling Vireo	338	169	3.75	5.92	
Philadelphia Vireo	46	28	0.17	0.36	
Red-eyed Vireo	352	176	6.13	7.22	
Golden-winged Warbler	63	30	0.11	0.37	

Table A3. Summary of BBS indices for Southern Ontario and Quebec.

Species	Potential Routes		Index		
	66-77	78-83	66-77	78-83	
Tennessee Warbler	60	31	0.23	0.48	
Nashville Warbler	194	103	0.63	1.10	
Northern Parula	42	24	0.24	1.21	
Yellow Warbler	352	176	7.76	10.19	
Chestnut-sided Warbler	260	130	1.65	2.25	
Magnolia Warbler	154	76	0.14	0.99	
Cape May Warbler	29	11	0.10	0.00	
Black-throated Blue Warbler	118	65	0.36	0.37	
Yellow-rumped Warbler	108	62	0.45	0.95	
Black-throated Green Warbler	194	98	0.26	0.46	
Blackburnian Warbler	144	79	0.24	0.27	
Pine Warbler	81	29	0.49	0.69	
Bay-breasted Warbler	43	29	0.26	0.10	
Blackpoll Warbler	16	10	0.13	0.00	
Cerulean Warbler	11	5	0.09	0.00	
Black-and-white Warbler	275	128	0.76	1.13	
American Redstart	326	156	1.50	2.36	
Ovenbird	335	166	2.50	3.46	
Northern Waterthrush	229	107	0.73	0.64	
Mourning Warbler	277	145	0.75	1.41	
Common Yellowthroat	352	176	9.95	11.96	
Wilson's Warbler	30	23	0.20	0.09	
Canada Warbler	156	87	0.33	0.41	
Yellow-breasted Chat	35	18	0.23	0.44	
Scarlet Tanager	323	161	0.82	0.75	
Northern Cardinal	197	105	3.49	3.26	
Rose-breasted Grosbeak	352	176	4.86	7.31	
Indigo Bunting	328	165	2.90	3.52	
Dickcissel	9	5	0.11	0.00	
Rufous-sided Towhee	268	131	0.98	0.70	
Chipping Sparrow	352	176	13.28	13.86	
Clay-coloured Sparrow	81	38	0.26	0.55	
Field Sparrow	305	150	2.53	2.81	
Vesper Sparrow	346	172	8.24	7.00	
Lark Sparrow	8	2	0.13	0.00	
Savannah Sparrow	352	176	52.65	50.26	D
Grasshopper Sparrow	240	113	1.49	1.48	
Henslow's Sparrow	49	25	0.08	0.08	
Song Sparrow	352	176	39.68	36.20	D
Lincoln's Sparrow	26	20	0.31	0.70	
Swamp Sparrow	300	151	1.36	1.22	
White-throated Sparrow	297	146	8.28	8.27	
White-crowned Sparrow	29	15	0.03	0.20	
Slate-coloured Junco	93	51	0.31	1.31	
Bobolink	352	176	49.14	55.64	I
Red-winged Blackbird	352	176	161.66	165.90	I
Eastern Meadowlark	352	176	29.36	22.32	D

Table A3. Summary of BBS indices for Southern Ontario and Quebec.

Species	Potential Routes		Index		
	66-77	78-83	66-77	78-83	
Western Meadowlark	178	87	0.29	0.24	
Rusty Blackbird	25	12	0.24	0.17	
Brewer's Blackbird	17	8	3.76	0.00	
Common Grackle	352	176	86.62	66.47	D
Brown-headed Cowbird	352	176	25.15	20.40	D
Orchard Oriole	48	25	0.60	0.64	
Baltimore Oriole	346	175	9.17	10.70	
Pine Grosbeak	7	5	0.14	0.00	
Purple Finch	277	134	0.80	1.50	
Red Crossbill	32	10	0.88	0.00	
White-winged Crossbill	24	15	0.13	0.13	
Pine Siskin	65	36	1.26	1.03	
American Goldfinch	352	176	23.77	18.01	D
Evening Grosbeak	115	57	0.52	1.07	
House Sparrow	352	176	70.64	72.41	

Table A4. Summary of BBS indices for Southern Prairies.

Species	Potential Routes		Index		
	66-77	78-83	66-77	78-83	
Common Loon	57	35	0.16	0.17	
Pied-billed Grebe	166	87	2.01	0.93	
Horned Grebe	197	103	1.67	1.39	
Red-necked Grebe	11	5	0.00	0.20	
Eared Grebe	154	84	3.42	2.08	
Western Grebe	44	17	9.93	31.06	I
American White Pelican	80	38	6.08	10.66	I
Double-crested Cormorant	82	44	4.18	1.64	D
American Bittern	220	105	2.35	0.71	
Great Blue Heron	149	72	1.63	0.46	
Great Egret	10	5	0.10	0.00	
Black-crowned Night-Heron	103	52	0.64	0.50	
Canada Goose	158	92	4.85	11.10	I
Wood Duck	16	7	0.06	0.29	
Green-winged Teal	212	100	1.72	0.71	
American Black Duck	15	7	0.07	0.14	
Mallard	270	146	34.21	36.76	
Northern Pintail	269	141	17.74	9.37	D
Blue-winged Teal	260	135	11.99	7.95	D
Cinnamon Teal	28	14	0.46	0.14	
Northern Shoveler	251	131	7.85	4.65	D
Gadwall	220	116	5.25	4.13	
American Wigeon	239	125	6.28	5.01	
Canvasback	192	99	6.51	3.35	D
Redhead	218	110	3.31	2.48	
Ring-necked Duck	79	38	0.30	0.39	
Greater Scaup	10	5	0.00	0.40	
Lesser Scaup	215	114	11.25	8.98	
White-winged Scoter	29	19	2.69	1.63	
Common Goldeneye	43	22	1.00	0.00	
Barrow's Goldeneye	1	4	1.00	1.00	
Bufflehead	57	40	0.70	0.80	
Hooded Merganser	10	4	0.00	0.25	
Common Merganser	9	9	0.11	0.67	
Ruddy Duck	199	100	2.64	2.08	
Osprey	0	2	n.d.	1.50	
Bald Eagle	8	5	0.00	0.20	
Northern Harrier	268	143	2.04	2.05	
Sharp-shinned Hawk	18	9	0.00	0.22	
Cooper's Hawk	69	33	0.14	0.15	
Northern Goshawk	32	14	0.13	0.00	
Broad-winged Hawk	34	18	0.12	0.11	
Swainson's Hawk	247	132	1.83	2.70	
Red-tailed Hawk	226	122	1.14	0.98	
Ferruginous Hawk	67	42	0.64	2.00	

Table A4. Summary of BBS indices for Southern Prairies.

Species	Potential Routes		Index		
	66-77	78-83	66-77	78-83	
Rough-Legged Hawk	26	12	0.15	0.17	
Unidentified Buteo	6	5	0.33	0.00	
American Kestrel	206	101	0.34	0.97	
Merlin	101	58	0.06	0.21	
Prairie Falcon	21	14	0.14	0.29	
Gray Partridge	251	135	0.76	1.42	
Ring-necked Pheasant	126	67	3.83	4.55	
Ruffed Grouse	44	23	0.27	1.04	
Sage Grouse	5	4	0.40	0.00	
Sharp-Tailed Grouse	157	84	0.78	0.83	
Yellow Rail	11	6	0.36	0.00	
Virginia Rail	40	18	0.15	0.28	
Sora	244	135	4.90	2.38	
American Coot	236	123	13.25	6.75	D
Sandhill Crane	20	12	1.05	0.00	
Black-bellied Plover	5	1	1.20	0.00	
Piping Plover	6	5	0.00	0.20	
Killdeer	269	144	14.16	15.25	
American Avocet	207	105	2.54	1.66	
Greater Yellowlegs	51	26	0.20	0.96	
Lesser Yellowlegs	150	75	1.93	2.16	
Solitary Sandpiper	80	35	0.16	0.43	
Willet	227	123	5.07	4.80	
Spotted Sandpiper	189	97	0.44	0.81	
Upland Sandpiper	193	98	1.15	1.89	
Long-billed Curlew	90	53	5.27	7.75	I
Marbled Godwit	254	135	5.52	6.45	
Least Sandpiper	10	5	2.60	0.20	D
Baird's Sandpiper	5	1	1.40	0.00	
Pectoral Sandpiper	12	8	0.17	0.75	
Short-Billed Dowitcher	13	1	0.15	0.00	
Common Snipe	218	120	2.03	1.67	
Wilson's Phalarope	236	123	3.67	2.30	
Franklin's Gull	247	122	21.30	12.46	D
Ring-billed Gull	230	117	17.47	29.47	I
California Gull	124	65	1.72	1.35	
Herring Gull	31	14	1.29	0.71	
Unidentified Gull	31	20	43.39	25.35	D
Common Tern	121	57	3.17	3.82	
Forster's Tern	23	14	1.83	0.00	
Black Tern	242	126	12.55	4.62	D
Rock Dove	253	133	7.51	9.36	
Mourning Dove	269	144	11.56	17.60	I
Black-billed Cuckoo	178	88	1.55	2.42	
Great Horned Owl	195	111	0.36	0.67	
Burrowing Owl	65	32	0.29	0.34	
Long-eared Owl	17	13	0.12	0.08	

Table A4. Summary of BBS indices for Southern Prairies.

Species	Potential Routes 66-77	Potential Routes 78-83	Index 66-77	Index 78-83	
Short-eared Owl	177	84	0.71	0.62	
Common Nighthawk	91	56	0.25	0.29	
Ruby-throated Hummingbird	27	10	0.11	0.00	
Rufous Hummingbird	0	2	n.d.	1.00	
Belted Kingfisher	55	27	0.18	0.15	
Red-headed Woodpecker	31	15	0.23	0.87	
Yellow-bellied Sapsucker	61	27	0.36	0.85	
Downy Woodpecker	63	27	0.30	0.37	
Hairy Woodpecker	80	36	0.24	0.47	
Black-backed Woodpecker	0	2	n.d.	0.50	
Yellow-shafted Flicker	230	120	2.92	2.08	
Red-shafted Flicker	21	12	1.57	0.08	D
Olive-sided Flycatcher	2	7	0.00	0.57	
Western Wood-Pewee	43	26	0.19	0.12	
Eastern Wood-Pewee	43	21	0.79	0.52	
Alder Flycatcher	104	57	0.39	1.19	
Willow Flycatcher	28	9	0.39	0.22	
Traill's Flycatcher Complex	104	48	0.38	0.00	
Least Flycatcher	230	124	3.15	4.33	
Dusky Flycatcher	0	2	n.d.	5.00	
Eastern Phoebe	123	65	0.62	0.34	
Say's Phoebe	30	26	0.20	0.15	
Great Crested Flycatcher	98	52	0.67	0.90	
Western Kingbird	261	135	2.96	2.89	
Eastern Kingbird	269	143	7.21	6.54	
Horned Lark	269	142	91.99	99.91	I
Purple Martin	125	60	1.46	1.20	
Tree Swallow	238	121	4.21	2.66	
Violet-green Swallow	6	5	0.17	1.40	I
Northern Rough-winged Swallow	76	39	0.32	1.62	
Bank Swallow	206	106	6.17	3.00	D
Cliff Swallow	197	110	21.57	26.32	I
Barn Swallow	270	146	14.49	16.05	
Gray Jay	1	4	7.00	1.00	D
Steller's Jay	0	2	n.d.	0.50	
Blue Jay	59	30	0.53	1.37	
Clark's Nutcracker	1	4	5.00	0.25	D
Black-billed Magpie	269	144	10.15	9.36	
American Crow	269	144	40.18	38.06	
Common Raven	10	9	0.10	0.67	
Black-capped Chickadee	133	68	0.50	0.68	
Mountain Chickadee	1	4	1.00	0.50	
Boreal Chickadee	1	4	7.00	0.25	D
Red-breasted Nuthatch	14	12	0.00	1.00	
White-breasted Nuthatch	28	13	0.11	0.08	
House Wren	258	136	10.70	16.13	I
Winter Wren	1	4	1.00	0.25	

Table A4. Summary of BBS indices for Southern Prairies.

Species	Potential Routes 66-77	Potential Routes 78-83	Index 66-77	Index 78-83	
Sedge Wren	103	53	0.54	0.49	
Marsh Wren	116	66	0.83	0.97	
American Dipper	0	2	n.d.	0.50	
Golden-crowned Kinglet	1	4	12.00	2.50	D
Ruby-crowned Kinglet	4	4	4.25	18.50	I
Northern Wheatear	10	5	0.00	0.40	
Eastern Bluebird	11	5	0.09	0.00	
Mountain Bluebird	89	43	1.64	1.35	
Townsend's Solitaire	1	2	1.00	0.00	
Veery	111	50	1.37	1.86	
Swainson's Thrush	25	18	1.12	3.50	I
Hermit Thrush	11	9	0.36	1.33	I
American Robin	259	132	6.05	9.96	I
Varied Thrush	1	4	34.00	12.50	D
Gray Catbird	210	106	2.59	2.50	
Sage Thrasher	8	5	0.13	0.00	
Brown Thrasher	247	130	1.36	1.35	
Sprague's Pipit	231	124	3.50	4.28	
Cedar Waxwing	152	76	1.76	2.67	
Loggerhead Shrike	244	126	1.23	0.52	
European Starling	269	144	19.48	19.02	
Solitary Vireo	11	5	0.00	0.20	
Yellow-throated Vireo	6	3	0.00	0.33	
Warbling Vireo	175	103	4.91	7.74	I
Philadelphia Vireo	25	9	0.36	0.11	
Red-eyed Vireo	157	92	2.89	2.77	
Tennessee Warbler	41	24	0.17	0.46	
Orange-crowned Warbler	15	9	0.07	0.11	
Nashville Warbler	9	5	0.44	0.00	
Yellow Warbler	259	137	5.21	4.20	
Audubon's Warbler	10	7	0.10	3.43	I
Yellow-rumped Warbler	9	9	7.67	4.89	D
Townsend's Warbler	1	4	2.00	2.75	
American Redstart	19	12	0.21	0.67	
Ovenbird	21	12	0.29	0.42	
Northern Waterthrush	1	4	2.00	5.75	I
Connecticut Warbler	6	4	0.00	1.00	
Mourning Warbler	18	10	0.06	0.10	
MacGillivray's Warbler	0	2	n.d.	27.00	
Common Yellowthroat	244	129	2.34	2.73	
Wilson's Warbler	7	9	0.14	3.67	I
Yellow-breasted Chat	14	10	0.14	0.00	
Western Tanager	8	7	0.13	1.29	I
Rose-breasted Grosbeak	73	38	0.74	0.34	
Black-headed Grosbeak	0	2	n.d.	1.50	
Lazuli Bunting	10	5	0.30	0.00	
Indigo Bunting	11	5	0.09	0.00	

Table A4. Summary of BBS indices for Southern Prairies.

Species	Potential Routes		Index		
	66-77	78-83	66-77	78-83	
Rufous-sided Towhee	90	46	0.31	0.26	
Chipping Sparrow	214	98	1.03	2.31	
Clay-coloured Sparrow	269	144	23.94	24.01	
Brewer's Sparrow	27	19	0.11	0.89	
Field Sparrow	5	0	0.20	n.d.	
Vesper Sparrow	266	144	19.15	21.67	
Lark Sparrow	77	38	0.52	0.24	
Lark Bunting	117	67	23.81	2.58	D
Savannah Sparrow	270	145	20.32	22.24	
Baird's Sparrow	204	116	3.27	3.51	
Grasshopper Sparrow	175	93	0.85	1.63	
Le Conte's Sparrow	150	76	1.35	0.66	
Sharp-tailed Sparrow	78	35	0.37	0.14	
Fox Sparrow	1	4	1.00	5.75	I
Song Sparrow	251	128	10.42	7.68	
Lincoln's Sparrow	10	3	0.40	5.00	I
Swamp Sparrow	13	8	0.08	0.13	
White-throated Sparrow	24	14	0.21	0.14	
White-crowned Sparrow	1	4	14.00	10.75	D
Slate-coloured Junco	7	10	4.14	1.70	D
Oregon Junco	0	2	n.d.	14.50	
McCown's Longspur	75	43	37.75	8.47	D
Chestnut-collared Longspur	181	93	34.17	34.30	
Snow Bunting	10	5	0.00	26.40	
Bobolink	201	108	3.87	4.88	
Red-winged Blackbird	269	144	107.37	102.01	D
Western Meadowlark	269	144	64.21	63.38	
Yellow-headed Blackbird	268	144	19.21	25.53	I
Rusty Blackbird	13	4	0.69	0.00	
Brewer's Blackbird	269	143	28.09	26.10	
Common Grackle	232	126	5.03	8.13	I
Brown-headed Cowbird	270	146	26.24	31.98	I
Orchard Oriole	29	16	0.10	0.81	
Baltimore Oriole	259	137	2.69	4.23	
Rosy Finch	0	2	n.d.	62.50	
Pine Grosbeak	0	2	n.d.	1.00	
Purple Finch	20	9	0.35	0.00	
Red Crossbill	11	14	1.27	0.71	
White-winged Crossbill	8	7	2.63	0.00	
Pine Siskin	68	45	1.57	2.67	
American Goldfinch	259	134	5.49	5.03	
Evening Grosbeak	0	2	n.d.	1.50	
House Sparrow	269	142	68.95	58.82	D

Table A5. Summary of BBS indices for Central Prairies.

Species	Potential Routes 66-77	Potential Routes 78-83	Index 66-77	Index 78-83	
Common Loon	119	101	0.69	1.12	
Pied-billed Grebe	136	112	1.90	1.04	
Horned Grebe	113	85	1.31	1.66	
Red-necked Grebe	103	78	1.98	2.40	
Eared Grebe	77	54	0.82	1.17	
Western Grebe	13	12	0.08	0.25	
American White Pelican	34	23	3.91	21.22	I
Double-crested Cormorant	12	10	0.17	2.90	I
American Bittern	192	137	3.83	1.63	
Great Blue Heron	122	99	0.43	0.63	
Black-crowned Night-Heron	47	30	0.23	0.40	
Canada Goose	162	107	3.34	4.44	
Wood Duck	20	14	0.10	0.36	
Green-winged Teal	159	105	3.65	2.19	
American Black Duck	23	14	0.00	0.29	
Mallard	235	177	26.48	32.18	I
Northern Pintail	186	127	8.08	3.09	D
Blue-winged Teal	220	157	7.55	7.63	
Cinnamon Teal	20	13	0.05	0.31	
Northern Shoveler	146	99	5.68	2.64	D
Gadwall	127	93	5.57	3.00	D
American Wigeon	156	116	4.12	3.12	
Canvasback	100	72	2.30	1.07	
Redhead	116	86	2.54	2.57	
Ring-necked Duck	57	40	0.28	1.33	
Greater Scaup	3	2	0.33	0.00	
Lesser Scaup	188	139	12.47	6.87	D
Common Eider	10	5	0.00	1.60	
Harlequin Duck	9	9	3.44	2.67	
Surf Scoter	2	0	3.00	n.d.	
White-winged Scoter	48	40	4.77	2.30	D
Common Goldeneye	131	107	0.38	0.78	
Barrow's Goldeneye	28	22	0.50	1.09	
Bufflehead	95	79	1.29	1.70	
Unidentified Goldeneye	0	4	n.d.	0.75	
Hooded Merganser	7	10	0.00	0.60	
Common Merganser	59	53	0.51	2.66	I
Red-breasted Merganser	2	8	0.50	0.50	
Ruddy Duck	125	89	2.54	2.53	
Turkey Vulture	3	5	0.33	0.00	
Osprey	7	11	0.14	0.27	
Bald Eagle	5	4	0.00	0.25	
Northern Harrier	215	140	1.13	0.98	
Sharp-shinned Hawk	51	37	0.10	0.19	
Cooper's Hawk	109	71	0.16	0.20	

Table A5. Summary of BBS indices for Central Prairies.

Species	Potential Routes 66-77	Potential Routes 78-83	Index 66-77	Index 78-83	
Northern Goshawk	58	37	0.12	0.11	
Unidentified Accipiter	1	1	0.00	1.00	
Broad-winged Hawk	76	42	0.17	0.19	
Swainson's Hawk	116	77	1.22	1.25	
Red-tailed Hawk	238	173	1.63	1.64	
Ferruginous Hawk	9	5	0.22	0.00	
Rough-Legged Hawk	10	7	0.10	0.14	
Unidentified Buteo	1	2	1.00	0.00	
Golden Eagle	14	14	0.21	0.07	
American Kestrel	239	178	1.46	1.56	
Merlin	91	67	0.22	0.21	
Peregrine Falcon	10	5	0.20	0.00	
Prairie Falcon	3	4	0.33	0.50	
Gray Partridge	109	70	0.26	0.66	
Ring-necked Pheasant	113	74	0.47	0.45	
Spruce Grouse	4	9	1.75	0.11	D
Blue Grouse	4	5	1.75	0.00	
Ruffed Grouse	201	143	1.02	1.29	
Sharp-Tailed Grouse	128	79	0.80	0.62	
Wild Turkey	10	4	0.00	0.25	
Yellow Rail	29	14	0.28	0.00	
Virginia Rail	10	7	0.00	0.29	
Sora	225	165	4.64	3.28	
American Coot	168	118	8.93	7.01	
Sandhill Crane	97	72	0.48	5.46	I
Killdeer	248	182	9.40	7.57	
American Avocet	23	14	1.48	2.36	
Greater Yellowlegs	45	29	0.42	0.69	
Lesser Yellowlegs	169	117	1.01	1.44	
Solitary Sandpiper	33	24	0.33	0.38	
Willet	80	59	3.71	2.71	
Spotted Sandpiper	228	162	0.84	1.07	
Upland Sandpiper	77	46	1.14	1.28	
Long-billed Curlew	23	14	0.43	0.29	
Hudsonian Godwit	10	4	0.00	0.50	
Marbled Godwit	145	88	2.31	4.10	
Pectoral Sandpiper	10	5	0.20	0.00	
Short-Billed Dowitcher	8	6	0.25	0.00	
Common Snipe	241	172	7.39	7.24	
Wilson's Phalarope	127	80	1.41	1.24	
Franklin's Gull	186	128	34.56	21.05	D
Bonaparte's Gull	43	39	0.40	3.18	I
Mew Gull	0	4	n.d.	2.50	
Ring-billed Gull	186	129	3.34	8.90	I
California Gull	55	38	1.02	2.45	
Herring Gull	56	45	0.89	2.09	
Unidentified Gull	22	22	0.41	0.86	

Table A5. Summary of BBS indices for Central Prairies.

Species	Potential Routes 66-77	Potential Routes 78-83	Index 66-77	Index 78-83	
Caspian Tern	10	4	0.00	0.25	
Common Tern	97	72	0.47	1.00	
Forster's Tern	30	25	0.33	0.88	
Black Tern	205	139	13.17	9.80	D
Rock Dove	197	129	4.49	6.43	
Mourning Dove	203	148	6.11	7.30	
Black-billed Cuckoo	118	85	2.05	3.47	
Yellow-billed Cuckoo	11	5	0.09	0.00	
Eastern Screech-Owl	11	5	0.09	0.00	
Great Horned Owl	214	147	0.54	0.73	
Northern Hawk-owl	10	5	0.30	0.00	
Burrowing Owl	7	4	1.00	0.25	D
Barred Owl	13	10	0.08	0.10	
Great Gray Owl	23	11	0.13	0.00	
Long-eared Owl	34	19	0.15	0.05	
Short-eared Owl	169	99	0.68	0.21	
Northern Saw-whet Owl	7	5	0.71	0.00	
Common Nighthawk	163	116	0.56	0.44	
Whip-Poor-Will	21	14	0.05	0.14	
Black Swift	6	5	1.00	0.40	
Chimney Swift	9	5	1.00	5.60	I
Ruby-throated Hummingbird	112	74	0.15	0.18	
Calliope Hummingbird	5	5	0.00	0.20	
Rufous Hummingbird	12	17	0.50	0.71	
Unidentified Hummingbird	5	5	0.00	0.20	
Belted Kingfisher	84	72	0.44	0.54	
Red-headed Woodpecker	30	19	0.40	0.26	
Yellow-bellied Sapsucker	204	154	1.30	1.21	
Downy Woodpecker	162	115	0.40	0.57	
Hairy Woodpecker	206	152	0.30	0.38	
Three-toed Woodpecker	8	15	0.50	0.73	
Black-backed Woodpecker	3	5	0.33	0.20	
Yellow-shafted Flicker	251	180	3.20	2.21	
Red-shafted Flicker	31	25	1.29	1.36	
Pileated Woodpecker	86	59	0.15	0.69	
Olive-sided Flycatcher	119	98	0.54	1.34	
Western Wood-Pewee	169	130	3.56	5.65	
Eastern Wood-Pewee	52	40	0.77	1.18	
Yellow-bellied Flycatcher	24	31	0.67	1.48	
Alder Flycatcher	233	170	5.42	8.56	
Willow Flycatcher	16	15	0.75	2.07	
Traill's Flycatcher Complex	158	92	3.31	0.28	
Least Flycatcher	254	184	9.85	12.12	
Hammond's Flycatcher	2	5	1.00	2.00	I
Dusky Flycatcher	10	14	1.40	4.07	I
Western Flycatcher	20	14	1.30	1.00	
Unidentified Empidonax Sp.	1	4	0.00	0.50	

Table A5. Summary of BBS indices for Central Prairies.

Species	Potential Routes		Index		
	66-77	78-83	66-77	78-83	
Eastern Phoebe	242	166	2.45	2.62	
Say's Phoebe	4	1	1.25	0.00	
Great Crested Flycatcher	108	78	1.49	1.62	
Western Kingbird	75	49	0.63	1.06	
Eastern Kingbird	233	168	4.26	3.65	
Horned Lark	198	132	5.98	4.80	
Purple Martin	132	82	1.64	1.27	
Tree Swallow	245	175	5.09	6.59	
Violet-green Swallow	1	4	0.00	7.25	
Northern Rough-winged Swallow	51	40	2.04	0.38	
Bank Swallow	183	132	2.31	5.94	I
Cliff Swallow	188	136	16.04	31.88	I
Barn Swallow	248	183	13.35	16.23	
Gray Jay	104	90	2.81	1.99	
Blue Jay	164	119	0.66	1.31	
Clark's Nutcracker	16	20	0.44	1.50	
Black-billed Magpie	236	167	13.87	15.23	
American Crow	249	182	41.28	41.98	
Common Raven	164	133	2.06	4.52	
Black-capped Chickadee	239	179	1.86	2.20	
Mountain Chickadee	7	10	1.29	2.40	I
Boreal Chickadee	59	48	0.53	0.92	
Red-breasted Nuthatch	102	87	0.60	1.32	
White-breasted Nuthatch	51	35	0.25	0.29	
Brown Creeper	18	15	0.11	0.27	
Rock Wren	5	6	0.00	0.50	
House Wren	238	169	13.29	16.76	I
Winter Wren	18	24	1.11	2.75	I
Sedge Wren	86	64	1.87	1.39	
Marsh Wren	92	71	0.48	1.04	
American Dipper	1	4	0.00	0.50	
Golden-crowned Kinglet	50	53	1.34	0.98	
Ruby-crowned Kinglet	136	114	2.41	4.23	
Eastern Bluebird	20	10	0.65	0.40	
Mountain Bluebird	138	97	1.67	1.37	
Townsend's Solitaire	15	16	1.73	2.75	
Veery	168	128	1.91	2.55	
Gray-cheeked Thrush	21	10	0.05	0.10	
Swainson's Thrush	200	154	4.78	9.23	I
Hermit Thrush	168	137	1.99	2.91	
American Robin	261	188	18.11	19.67	
Varied Thrush	27	27	1.81	5.56	I
Gray Catbird	194	129	2.63	2.05	
Northern Mockingbird	20	9	0.10	0.00	
Brown Thrasher	115	78	1.39	1.29	
Water Pipit	5	4	0.60	0.00	
Sprague's Pipit	141	96	2.49	3.16	

Table A5. Summary of BBS indices for Central Prairies.

Species	Potential Routes		Index		
	66-77	78-83	66-77	78-83	
Bohemian Waxwing	6	4	0.67	3.25	I
Cedar Waxwing	227	177	2.27	3.50	
Loggerhead Shrike	106	59	0.41	0.12	
European Starling	240	157	27.86	24.55	D
Solitary Vireo	77	72	0.60	0.61	
Yellow-throated Vireo	30	14	0.10	0.14	
Warbling Vireo	237	174	5.10	6.57	
Philadelphia Vireo	85	64	0.53	0.45	
Red-eyed Vireo	250	182	11.51	22.30	I
Tennessee Warbler	160	131	2.40	4.29	
Orange-crowned Warbler	68	72	1.37	1.61	
Nashville Warbler	22	27	1.73	9.74	I
Northern Parula	3	5	1.67	9.80	I
Yellow Warbler	247	179	11.47	13.75	
Chestnut-sided Warbler	79	52	1.09	3.67	I
Magnolia Warbler	40	54	2.03	2.94	
Cape May Warbler	13	15	0.46	2.87	I
Audubon's Warbler	23	26	3.17	10.58	I
Yellow-rumped Warbler	136	113	2.52	5.01	
Black-throated Gray Warbler	0	1	n.d.	2.00	
Townsend's Warbler	11	16	0.09	0.31	
Black-throated Green Warbler	20	21	0.55	2.19	I
Blackburnian Warbler	5	18	6.40	2.94	D
Palm Warbler	16	35	0.56	0.89	
Bay-breasted Warbler	10	17	0.60	0.71	
Blackpoll Warbler	35	32	1.00	1.44	
Black-and-white Warbler	82	80	0.28	1.20	
American Redstart	128	106	0.63	1.85	
Ovenbird	212	155	1.83	5.25	I
Northern Waterthrush	71	65	0.79	1.43	
Connecticut Warbler	120	94	0.46	2.60	
Mourning Warbler	179	133	1.54	4.16	
MacGillivray's Warbler	24	18	1.13	1.72	
Common Yellowthroat	238	176	5.74	9.30	I
Wilson's Warbler	41	49	0.85	2.41	
Canada Warbler	13	16	3.54	2.56	
Scarlet Tanager	14	10	0.21	2.00	I
Western Tanager	56	37	0.88	0.32	
Rose-breasted Grosbeak	210	150	1.70	2.99	
Black-headed Grosbeak	4	5	0.50	0.00	
Lazuli Bunting	5	5	5.80	5.80	
Indigo Bunting	25	18	0.16	0.11	
Dickcissel	20	10	0.10	0.00	
Rufous-sided Towhee	44	25	0.61	0.32	
Chipping Sparrow	245	176	6.71	13.73	I
Clay-coloured Sparrow	247	182	31.68	33.51	
Brewer's Sparrow	16	13	0.19	0.08	

Table A5. Summary of BBS indices for Central Prairies.

Species	Potential Routes 66-77	Potential Routes 78-83	Index 66-77	Index 78-83	
Vesper Sparrow	237	160	13.62	13.91	
Lark Sparrow	17	15	0.12	0.73	
Lark Bunting	7	9	0.57	0.33	
Savannah Sparrow	250	173	19.78	25.16	I
Baird's Sparrow	42	30	5.79	4.80	
Grasshopper Sparrow	25	23	1.40	1.17	
Le Conte's Sparrow	212	158	3.28	2.89	
Sharp-tailed Sparrow	80	49	0.30	0.20	
Fox Sparrow	36	33	0.61	0.58	
Song Sparrow	242	177	24.27	21.58	
Lincoln's Sparrow	130	109	4.80	10.27	I
Swamp Sparrow	92	74	0.74	0.95	
White-throated Sparrow	213	159	9.43	11.38	
Golden-crowned Sparrow	4	5	0.50	0.20	
White-crowned Sparrow	36	30	4.44	8.63	I
Slate-coloured Junco	142	117	5.80	4.94	
Oregon Junco	21	22	4.95	10.27	I
McCown's Longspur	0	4	n.d.	4.25	
Chestnut-collared Longspur	45	26	1.27	1.65	
Bobolink	116	86	3.91	5.48	
Red-winged Blackbird	247	179	55.43	51.81	D
Eastern Meadowlark	21	10	0.05	0.10	
Western Meadowlark	218	151	16.82	12.89	D
Yellow-headed Blackbird	187	123	12.16	11.87	
Rusty Blackbird	54	41	2.33	0.66	
Brewer's Blackbird	235	171	26.71	25.47	
Common Grackle	199	141	4.33	4.16	
Brown-headed Cowbird	242	170	16.21	14.31	
Orchard Oriole	9	5	0.00	0.80	
Baltimore Oriole	230	162	5.54	7.15	
Bullock's Oriole	5	5	0.00	0.60	
Pine Grosbeak	11	16	0.18	0.50	
Purple Finch	150	115	0.33	0.30	
Red Crossbill	38	33	0.84	1.61	
White-winged Crossbill	56	50	1.82	1.68	
Pine Siskin	205	151	7.31	7.00	
American Goldfinch	214	152	6.61	8.88	
Evening Grosbeak	49	49	0.35	1.49	
House Sparrow	235	163	20.34	16.53	D

Table A6. Summary of BBS indices for Southern British Columbia.

Species	Potential Routes 66-77	Potential Routes 78-83	Index 66-77	Index 78-83	
Pacific Loon	3	1	0.33	0.00	
Common Loon	187	128	1.05	1.48	
Pied-billed Grebe	66	55	0.35	2.22	
Horned Grebe	26	22	0.54	0.18	
Red-necked Grebe	78	51	0.96	1.43	
Eared Grebe	17	19	0.47	1.58	
Western Grebe	54	33	2.76	0.76	D
Double-crested Cormorant	10	7	0.50	1.00	
Pelagic Cormorant	12	9	4.08	7.67	I
American Bittern	71	50	0.42	0.52	
Great Blue Heron	113	87	2.27	1.70	
Green-backed Heron	24	9	0.13	0.22	
Tundra Swan	7	5	0.29	0.20	
Trumpeter Swan	19	14	0.11	0.07	
Canada Goose	145	103	2.18	5.93	I
Wood Duck	44	27	0.66	1.04	
Green-winged Teal	49	32	0.35	0.72	
Mallard	188	133	4.16	5.49	
Northern Pintail	46	35	1.07	0.23	
Blue-winged Teal	92	76	0.74	1.45	
Cinnamon Teal	38	32	0.71	0.78	
Northern Shoveler	28	28	0.57	0.25	
Gadwall	12	5	1.50	0.40	D
American Wigeon	43	38	2.02	1.24	
Canvasback	19	17	0.32	0.24	
Redhead	24	26	0.71	2.42	I
Ring-necked Duck	70	55	0.81	1.16	
Greater Scaup	5	5	3.20	2.20	D
Lesser Scaup	41	41	0.85	0.71	
Unidentified Scaup	4	2	0.00	1.00	
Harlequin Duck	26	18	0.73	4.56	I
Surf Scoter	22	12	1.86	7.00	I
White-winged Scoter	12	9	0.25	1.22	I
Common Goldeneye	54	52	1.89	0.54	
Barrow's Goldeneye	76	67	1.07	1.03	
Bufflehead	43	36	2.16	0.19	D
Hooded Merganser	36	31	0.25	0.29	
Common Merganser	148	106	1.19	1.11	
Red-breasted Merganser	10	6	0.20	0.67	
Unidentified Duck	1	2	0.00	3.00	
Ruddy Duck	27	27	1.59	4.00	I
Turkey Vulture	40	21	0.45	0.33	
Osprey	124	82	0.65	0.60	
Bald Eagle	109	76	0.84	1.41	
Northern Harrier	35	29	0.29	0.38	

Table A6. Summary of BBS indices for Southern British Columbia.

Species	Potential Routes 66-77	Potential Routes 78-83	Index 66-77	Index 78-83	
Sharp-shinned Hawk	28	17	0.54	0.18	
Cooper's Hawk	69	46	0.20	0.15	
Northern Goshawk	5	5	0.40	0.00	
Broad-winged Hawk	5	5	0.00	0.20	
Swainson's Hawk	42	30	0.12	0.27	
Red-tailed Hawk	187	130	0.44	0.58	
Golden Eagle	26	23	0.19	0.09	
American Kestrel	199	128	1.16	1.81	
Merlin	64	51	0.14	0.10	
Gray Partridge	5	5	0.00	0.60	
Chukar	8	7	0.63	0.86	
Ring-necked Pheasant	98	62	6.26	6.81	
Spruce Grouse	8	7	0.25	0.00	
Blue Grouse	126	82	3.13	2.76	
Ruffed Grouse	191	135	0.91	0.70	
Sharp-Tailed Grouse	4	2	0.25	0.00	
California Quail	49	36	3.37	2.11	
Virginia Rail	29	17	0.07	0.35	
Sora	80	66	0.49	1.09	
American Coot	49	44	3.00	8.68	I
Sandhill Crane	23	21	0.26	0.57	
Killdeer	221	149	4.01	4.05	
American Black Oystercatcher	5	5	3.80	3.60	
Greater Yellowlegs	43	22	0.65	1.00	
Lesser Yellowlegs	8	10	0.00	1.80	
Solitary Sandpiper	36	19	0.39	0.11	
Spotted Sandpiper	193	121	1.82	2.28	
Long-billed Curlew	32	23	1.09	0.70	
Least Sandpiper	26	16	0.08	0.25	
Common Snipe	186	136	3.92	3.63	
Wilson's Phalarope	14	13	0.21	0.62	
Bonaparte's Gull	16	18	0.94	1.00	
Heermann's Gull	5	5	0.20	0.00	
Mew Gull	16	16	0.69	2.31	I
Ring-billed Gull	33	23	0.33	1.61	I
California Gull	18	16	0.83	0.00	
Herring Gull	45	35	0.42	2.34	I
Glaucous-winged Gull	92	54	22.00	37.43	I
Unidentified Gull	4	2	0.50	0.00	
Black Tern	35	28	2.14	2.54	
Pigeon Guillemot	7	7	2.29	0.57	D
Marbled Murrelet	17	15	7.12	0.80	D
Rhinoceros Auklet	5	5	17.60	15.80	D
Rock Dove	112	80	9.66	9.01	
Band-tailed Pigeon	92	56	8.87	6.68	D
Mourning Dove	141	103	4.16	3.31	
Common Barn Owl	7	4	0.00	0.25	

Table A6. Summary of BBS indices for Southern British Columbia.

Species	Potential Routes 66-77	Potential Routes 78-83	Index 66-77	Index 78-83	
Eastern Screech-Owl	9	8	0.33	0.13	
Great Horned Owl	25	22	0.24	0.45	
Northern Pygmy-Owl	26	28	0.19	0.18	
Barred Owl	18	10	0.06	0.20	
Great Gray Owl	16	13	0.06	0.15	
Short-eared Owl	23	18	0.13	0.06	
Northern Saw-whet Owl	10	5	0.10	0.00	
Common Nighthawk	199	131	1.46	1.60	
Common Poorwill	5	4	0.20	0.50	
Black Swift	123	71	9.92	3.48	D
Vaux's Swift	106	61	2.20	1.30	
Black-chinned Hummingbird	30	25	0.30	0.12	
Calliope Hummingbird	108	70	0.66	0.83	
Rufous Hummingbird	248	154	2.97	2.51	
Unidentified Hummingbird	8	7	0.00	0.57	
Belted Kingfisher	231	148	0.84	0.74	
Lewis's Woodpecker	60	42	0.50	0.24	
Yellow-bellied Sapsucker	236	152	2.73	3.20	
Downy Woodpecker	194	136	0.69	0.76	
Hairy Woodpecker	220	154	1.00	0.88	
Three-toed Woodpecker	31	22	0.29	0.27	
Black-backed Woodpecker	29	19	0.38	0.11	
Yellow-shafted Flicker	60	37	0.93	2.43	
Red-shafted Flicker	261	171	5.11	5.71	
Pileated Woodpecker	205	144	0.72	0.97	
Olive-sided Flycatcher	248	153	2.91	1.93	
Western Wood-Pewee	249	159	5.98	5.43	
Alder Flycatcher	119	79	1.54	1.11	
Willow Flycatcher	220	160	5.20	4.79	
Traill's Flycatcher Complex	117	45	2.65	0.00	
Least Flycatcher	165	107	2.12	1.31	
Hammond's Flycatcher	197	139	8.01	6.10	
Dusky Flycatcher	188	132	4.37	8.59	I
Western Flycatcher	196	131	2.89	3.02	
Unidentified Empidonax Sp.	21	14	1.29	0.00	
Eastern Phoebe	13	6	1.38	0.67	D
Say's Phoebe	67	48	0.34	0.46	
Western Kingbird	113	81	2.64	2.68	
Eastern Kingbird	156	111	2.00	1.77	
Eurasian Skylark	5	5	8.40	5.60	
Horned Lark	4	1	7.50	15.00	I
Purple Martin	15	10	0.00	0.20	
Tree Swallow	260	169	8.67	9.83	
Violet-green Swallow	235	161	9.51	8.50	
Northern Rough-winged Swallow	214	149	4.41	6.44	
Bank Swallow	113	85	11.33	8.87	D
Cliff Swallow	221	149	11.66	12.09	

Table A6. Summary of BBS indices for Southern British Columbia.

Species	Potential Routes		Index		
	66-77	78-83	66-77	78-83	
Barn Swallow	251	166	18.98	20.90	
Gray Jay	153	107	1.31	0.65	
Steller's Jay	176	109	1.88	2.66	
Clark's Nutcracker	57	40	0.79	1.23	
Black-billed Magpie	80	65	6.29	8.68	I
American Crow	210	133	24.17	32.74	I
Northwestern Crow	78	52	41.28	50.40	I
Common Raven	249	166	5.62	9.57	I
Black-capped Chickadee	225	146	9.89	9.46	
Mountain Chickadee	127	96	5.24	6.67	
Boreal Chickadee	15	4	0.53	0.00	
Chestnut-backed Chickadee	123	80	11.59	13.06	
Bushtit	51	28	3.31	9.11	I
Red-breasted Nuthatch	239	161	3.26	4.50	
White-breasted Nuthatch	38	34	0.89	0.53	
Pygmy Nuthatch	15	12	2.47	1.17	D
Brown Creeper	133	93	0.65	0.83	
Rock Wren	36	23	0.78	0.17	
Bewick's Wren	68	41	5.82	8.05	I
House Wren	108	73	1.15	1.36	
Winter Wren	203	138	5.33	7.24	
Marsh Wren	78	60	0.51	0.75	
American Dipper	61	37	0.20	0.24	
Golden-crowned Kinglet	229	147	4.96	4.92	
Ruby-crowned Kinglet	229	145	6.86	5.17	
Western Bluebird	8	7	0.50	0.71	
Mountain Bluebird	144	93	2.13	1.61	
Townsend's Solitaire	128	99	1.34	1.52	
Veery	155	118	6.87	6.78	
Swainson's Thrush	266	171	35.87	28.06	D
Hermit Thrush	177	109	2.44	3.33	
American Robin	268	171	61.21	61.29	
Varied Thrush	208	139	7.33	7.24	
Gray Catbird	140	99	1.45	0.72	
Sprague's Pipit	5	5	0.20	0.00	
Bohemian Waxwing	25	10	1.08	0.00	
Cedar Waxwing	233	157	5.42	4.96	
Loggerhead Shrike	2	0	0.50	n.d.	
European Starling	254	166	59.05	54.87	D
Crested Myna	2	2	0.50	0.00	
Solitary Vireo	215	151	3.74	3.34	
Hutton's Vireo	33	25	0.55	0.24	
Warbling Vireo	259	170	8.40	7.91	
Red-eyed Vireo	246	152	9.57	11.63	
Tennessee Warbler	81	43	2.56	0.81	D
Orange-crowned Warbler	248	166	7.14	7.07	
Nashville Warbler	100	74	1.11	2.08	

Table A6. Summary of BBS indices for Southern British Columbia.

Species	Potential Routes		Index		
	66-77	78-83	66-77	78-83	
Yellow Warbler	262	170	9.52	8.27	
Magnolia Warbler	54	26	3.20	0.54	D
Audubon's Warbler	259	167	7.76	10.13	
Yellow-rumped Warbler	23	7	2.00	0.00	
Black-throated Gray Warbler	68	41	3.04	1.34	D
Townsend's Warbler	199	125	3.55	6.04	
Blackpoll Warbler	32	8	4.94	0.13	D
Black-and-white Warbler	1	0	1.00	n.d.	
American Redstart	174	113	5.47	2.71	D
Ovenbird	18	15	0.00	0.20	
Northern Waterthrush	164	110	4.79	4.36	
MacGillivray's Warbler	239	147	9.21	10.04	
Common Yellowthroat	242	157	2.69	3.22	
Wilson's Warbler	242	164	4.16	1.88	
Yellow-breasted Chat	3	3	0.67	0.00	
Western Tanager	250	165	6.79	5.79	
Black-headed Grosbeak	140	91	2.11	1.70	
Lazuli Bunting	119	97	3.50	2.34	
Rufous-sided Towhee	156	99	8.73	8.23	
American Tree Sparrow	9	5	0.33	0.00	
Chipping Sparrow	262	169	15.96	15.86	
Clay-coloured Sparrow	38	28	1.26	1.36	
Brewer's Sparrow	8	7	0.38	0.00	
Vesper Sparrow	118	104	6.40	6.08	
Lark Sparrow	35	27	0.29	0.59	
Savannah Sparrow	209	133	6.60	6.74	
Grasshopper Sparrow	12	8	0.25	0.25	
Fox Sparrow	46	30	2.98	3.90	
Song Sparrow	267	169	11.46	10.92	
Lincoln's Sparrow	118	71	2.36	1.48	
Swamp Sparrow	2	4	1.00	0.00	
White-throated Sparrow	25	9	4.16	2.78	D
Golden-crowned Sparrow	26	7	0.35	0.00	
White-crowned Sparrow	169	106	4.73	3.16	
Harris's Sparrow	3	5	0.00	0.20	
Slate-coloured Junco	9	1	0.44	0.00	
Oregon Junco	267	171	12.65	15.87	
Bobolink	65	60	1.40	1.77	
Red-winged Blackbird	242	160	10.18	10.66	
Western Meadowlark	151	108	11.71	14.56	I
Yellow-headed Blackbird	80	57	2.44	7.77	I
Rusty Blackbird	60	31	1.13	0.29	
Brewer's Blackbird	235	153	18.72	16.05	
Brown-headed Cowbird	240	166	11.16	8.99	
Baltimore Oriole	5	5	0.20	0.00	
Bullock's Oriole	104	74	1.14	2.07	
Pine Grosbeak	61	36	0.98	0.58	

Table A6. Summary of BBS indices for Southern British Columbia.

Species	Potential Routes		Index		
	66-77	78-83	66-77	78-83	
Purple Finch	162	103	2.35	1.94	
Cassin's Finch	84	70	2.87	2.23	
House Finch	87	58	8.51	11.17	I
Red Crossbill	179	129	5.72	8.36	
White-winged Crossbill	35	20	0.43	0.30	
Pine Siskin	266	171	26.61	19.82	D
American Goldfinch	164	112	9.37	6.41	D
Evening Grosbeak	207	145	4.57	1.90	
House Sparrow	126	89	16.31	9.91	

Table A7. Summary of BBS indices for Labrador.

Species	Potential Routes 66-77	Potential Routes 78-83	Index 66-77	Index 78-83
Common Loon	4	1	0.50	2.00
American Bittern	0	1	n.d.	4.00
Canada Goose	9	3	1.89	5.67
Green-winged Teal	4	1	6.50	3.00
American Black Duck	9	2	0.78	0.50
Northern Pintail	5	1	0.00	6.00
Lesser Scaup	4	1	0.00	2.00
Surf Scoter	4	1	0.00	2.00
Common Goldeneye	9	2	1.00	1.00
Hooded Merganser	4	1	0.25	0.00
Common Merganser	9	2	0.44	0.50
Osprey	9	2	0.33	0.00
Northern Goshawk	4	1	0.25	2.00
Red-tailed Hawk	0	1	n.d.	1.00
Spruce Grouse	5	1	0.20	0.00
Semipalmated Plover	9	2	0.67	0.50
Greater Yellowlegs	9	2	7.33	8.50
Solitary Sandpiper	9	2	9.22	4.50
Spotted Sandpiper	9	3	1.67	0.67
Least Sandpiper	9	2	1.56	0.00
Short-Billed Dowitcher	4	1	3.00	11.00
Common Snipe	9	3	7.33	7.67
Red-necked Phalarope	9	2	1.56	2.00
Herring Gull	9	2	2.89	3.50
Common Tern	9	2	0.89	1.00
Arctic Tern	4	1	1.00	0.00
Northern Hawk-owl	4	1	0.25	0.00
Belted Kingfisher	5	1	0.20	0.00
Three-toed Woodpecker	9	2	1.67	1.00
Black-backed Woodpecker	9	2	0.78	0.00
Yellow-shafted Flicker	5	1	0.40	0.00
Olive-sided Flycatcher	5	2	0.20	0.50
Yellow-bellied Flycatcher	9	2	1.67	0.00
Alder Flycatcher	0	1	n.d.	1.00
Least Flycatcher	0	1	n.d.	1.00
Horned Lark	4	1	0.50	0.00
Tree Swallow	9	2	6.56	1.00
Bank Swallow	5	2	0.40	2.50
Gray Jay	9	3	13.44	7.00
American Crow	0	1	n.d.	3.00
Common Raven	5	2	0.80	1.50
Black-capped Chickadee	4	1	0.25	0.00
Boreal Chickadee	9	3	8.89	3.33
Ruby-crowned Kinglet	9	3	1.89	8.33
Gray-cheeked Thrush	9	2	9.44	16.50

Table A7. Summary of BBS indices for Labrador.

Species	Potential Routes		Index	
	66-77	78-83	66-77	78-83
Swainson's Thrush	9	3	4.89	23.67
Hermit Thrush	9	2	14.78	12.00
American Robin	9	3	20.22	12.00
Northern Shrike	5	1	0.40	0.00
Tennessee Warbler	9	2	8.78	3.50
Yellow Warbler	9	3	1.22	4.67
Yellow-rumped Warbler	9	3	15.78	9.33
Black-throated Green Warbler	0	1	n.d.	4.00
Blackburnian Warbler	5	1	0.60	0.00
Palm Warbler	4	1	0.75	0.00
Bay-breasted Warbler	4	1	0.25	0.00
Blackpoll Warbler	9	3	10.33	10.00
Northern Waterthrush	9	3	12.44	16.00
Wilson's Warbler	9	3	3.44	15.00
American Tree Sparrow	9	2	1.67	1.00
Savannah Sparrow	9	2	8.00	1.50
Fox Sparrow	9	3	6.11	18.67
Lincoln's Sparrow	9	3	2.56	4.67
Swamp Sparrow	4	2	0.75	1.00
White-throated Sparrow	9	3	2.33	17.33
White-crowned Sparrow	9	3	40.33	20.33
Slate-coloured Junco	9	3	16.44	16.33
Rusty Blackbird	9	3	15.44	6.33
Pine Grosbeak	9	2	20.56	20.50
White-winged Crossbill	9	2	5.00	.00
Common Redpoll	9	2	4.78	1.00
Pine Siskin	0	1	n.d.	5.00
Evening Grosbeak	5	1	0.40	0.00

Table A8. Summary of BBS indices for routes outside study regions (region 8).

Species	Potential Routes 66-77	Potential Routes 78-83	Index 66-77	Index 78-83
Pacific Loon	1	2	36.00	37.50
Common Loon	2	4	7.50	2.25
Great Blue Heron	1	0	1.00	n.d.
Canada Goose	1	2	53.00	61.00
Green-winged Teal	1	2	4.00	0.00
American Black Duck	0	2	n.d.	1.00
Mallard	2	4	0.50	0.75
Northern Pintail	1	2	22.00	9.00
American Wigeon	1	2	0.00	0.50
Greater Scaup	1	2	10.00	6.50
Common Eider	1	2	29.00	5.00
Oldsquaw	1	2	31.00	17.50
Black Scoter	1	2	0.00	63.50
Surf Scoter	1	2	0.00	6.00
White-winged Scoter	1	2	0.00	4.50
Common Goldeneye	2	3	5.50	0.33
Bufflehead	0	2	n.d.	1.00
Common Merganser	1	2	5.00	0.50
Red-breasted Merganser	2	2	2.50	5.00
Osprey	1	0	1.00	n.d.
Bald Eagle	1	0	1.00	n.d.
Northern Harrier	1	4	0.00	0.50
Cooper's Hawk	0	2	n.d.	0.50
Northern Goshawk	0	2	n.d.	0.50
Red-tailed Hawk	0	2	n.d.	1.50
Rough-Legged Hawk	1	2	0.00	0.50
American Kestrel	0	3	n.d.	5.33
Merlin	1	2	1.00	1.00
Willow Ptarmigan	1	2	2.00	3.00
Sora	0	2	n.d.	2.50
Lesser Golden-Plover	1	2	9.00	16.50
Semipalmated Plover	1	2	6.00	13.50
Killdeer	1	6	1.00	1.00
Greater Yellowlegs	0	6	n.d.	1.33
Lesser Yellowlegs	1	6	55.00	20.67
Solitary Sandpiper	0	2	n.d.	1.50
Spotted Sandpiper	2	7	3.00	1.14
Whimbrel	1	2	33.00	48.00
Hudsonian Godwit	1	2	22.00	17.00
Semipalmated Sandpiper	1	2	6.00	1.00
Least Sandpiper	1	2	1.00	7.50
Dunlin	1	2	1.00	3.50
Stilt Sandpiper	1	2	4.00	3.50
Short-Billed Dowitcher	1	2	18.00	19.50

Table A8. Summary of BBS indices for routes outside study regions (region 8).

Species	Potential Routes		Index	
	66-77	78-83	66-77	78-83
Common Snipe	1	6	14.00	7.17
Red-necked Phalarope	1	2	6.00	11.00
Parasitic Jaeger	1	2	5.00	4.50
Bonaparte's Gull	1	2	24.00	27.50
Herring Gull	2	4	123.00	31.00
Common Tern	1	0	32.00	n.d.
Arctic Tern	1	2	77.00	145.00
Short-eared Owl	1	2	0.00	1.00
Common Nighthawk	0	2	n.d.	1.00
Belted Kingfisher	0	3	n.d.	1.00
Yellow-bellied Sapsucker	1	2	1.00	1.00
Hairy Woodpecker	1	2	2.00	2.00
Three-toed Woodpecker	0	2	n.d.	0.50
Black-backed Woodpecker	0	2	n.d.	0.50
Yellow-shafted Flicker	2	9	1.00	3.67
Olive-sided Flycatcher	2	6	1.50	0.83
Western Wood-Pewee	0	2	n.d.	13.00
Alder Flycatcher	0	5	n.d.	17.40
Traill's Flycatcher Complex	1	0	1.00	n.d.
Least Flycatcher	1	3	9.00	18.00
Eastern Kingbird	0	2	n.d.	0.50
Horned Lark	1	2	5.00	3.00
Tree Swallow	2	8	2.50	3.38
Barn Swallow	1	4	0.00	4.75
Gray Jay	2	9	4.00	7.00
American Crow	2	3	8.50	3.33
Common Raven	1	7	10.00	7.43
Black-capped Chickadee	0	2	n.d.	9.00
Boreal Chickadee	0	4	n.d.	2.00
Red-breasted Nuthatch	1	2	3.00	1.00
White-breasted Nuthatch	0	1	n.d.	1.00
House Wren	0	1	n.d.	1.00
Winter Wren	1	5	8.00	2.60
Ruby-crowned Kinglet	2	8	7.00	10.38
Veery	0	1	n.d.	4.00
Gray-cheeked Thrush	1	3	6.00	12.00
Swainson's Thrush	2	8	26.00	13.75
Hermit Thrush	0	6	n.d.	49.50
Wood Thrush	0	1	n.d.	3.00
American Robin	1	9	29.00	10.89
Water Pipit	1	2	1.00	2.00
Bohemian Waxwing	1	2	0.00	0.50
Cedar Waxwing	0	3	n.d.	3.33
Northern Shrike	1	2	0.00	1.50
European Starling	1	2	1.00	1.50
Philadelphia Vireo	0	3	n.d.	3.00

Table A8. Summary of BBS indices for routes outside study regions (region 8).

Species	Potential Routes		Index	
	66-77	78-83	66-77	78-83
Red-eyed Vireo	1	3	72.00	40.33
Tennessee Warbler	1	8	24.00	23.38
Orange-crowned Warbler	1	7	9.00	3.00
Nashville Warbler	0	3	n.d.	4.33
Yellow Warbler	2	7	8.00	6.57
Chestnut-sided Warbler	0	1	n.d.	1.00
Magnolia Warbler	1	3	11.00	1.00
Audubon's Warbler	0	2	n.d.	3.00
Yellow-rumped Warbler	2	8	18.50	16.88
Black-throated Green Warbler	0	1	n.d.	3.00
Pine Warbler	0	1	n.d.	7.00
Palm Warbler	0	2	n.d.	0.50
Bay-breasted Warbler	0	2	n.d.	5.00
Blackpoll Warbler	2	4	6.00	3.50
Black-and-white Warbler	0	2	n.d.	1.00
Ovenbird	1	3	13.00	25.67
Northern Waterthrush	0	6	n.d.	2.00
Mourning Warbler	0	3	n.d.	14.67
Common Yellowthroat	0	4	n.d.	3.00
Wilson's Warbler	0	2	n.d.	4.50
Canada Warbler	0	3	n.d.	10.67
Western Tanager	0	2	n.d.	3.00
Rose-breasted Grosbeak	0	2	n.d.	8.00
American Tree Sparrow	1	2	30.00	23.50
Chipping Sparrow	2	8	9.00	22.50
Clay-coloured Sparrow	0	2	n.d.	3.50
Savannah Sparrow	1	6	53.00	15.67
Le Conte's Sparrow	0	2	n.d.	3.00
Fox Sparrow	0	3	n.d.	5.00
Song Sparrow	1	1	9.00	1.00
Lincoln's Sparrow	1	8	2.00	14.50
Swamp Sparrow	0	6	n.d.	1.67
White-throated Sparrow	2	9	1.50	32.22
White-crowned Sparrow	1	6	59.00	21.50
Harris's Sparrow	1	2	2.00	7.00
Slate-coloured Junco	2	9	1.50	35.33
Lapland Longspur	1	2	2.00	0.00
Smith's Longspur	1	2	6.00	5.00
Red-winged Blackbird	0	3	n.d.	14.67
Rusty Blackbird	1	4	3.00	0.25
Common Grackle	1	1	1.00	2.00
Pine Grosbeak	1	2	0.00	0.50
Purple Finch	0	2	n.d.	1.50
White-winged Crossbill	0	3	n.d.	7.00
Common Redpoll	2	2	5.00	34.50
Pine Siskin	0	3	n.d.	16.33

Table A9. Summary of BBS indices for Northern B.C. and Yukon.

Species	Potential Routes		Index	
	66-77	78-83	66-77	78-83
Red-throated Loon	2	1	1.50	1.00
Pacific Loon	5	0	0.20	n.d.
Common Loon	15	1	0.93	1.00
Horned Grebe	7	1	0.57	2.00
Green-winged Teal	6	1	0.50	2.00
Mallard	9	0	0.44	n.d.
Northern Pintail	12	1	0.42	2.00
American Wigeon	9	1	1.11	2.00
Canvasback	3	0	2.00	n.d.
Greater Scaup	7	0	19.57	n.d.
Lesser Scaup	14	1	1.57	8.00
Unidentified Scaup	12	0	8.33	n.d.
Harlequin Duck	5	1	0.40	3.00
Oldsquaw	3	0	0.33	n.d.
Surf Scoter	8	0	5.88	n.d.
White-winged Scoter	7	0	5.86	n.d.
Common Goldeneye	2	0	1.50	n.d.
Barrow's Goldeneye	16	0	4.44	n.d.
Bufflehead	4	1	16.00	14.00
Common Merganser	5	0	4.20	n.d.
Red-breasted Merganser	14	0	0.79	n.d.
Bald Eagle	8	0	0.25	n.d.
Northern Harrier	8	0	0.63	n.d.
Sharp-shinned Hawk	3	0	0.33	n.d.
Northern Goshawk	5	0	0.40	n.d.
Swainson's Hawk	0	1	n.d.	1.00
Red-tailed Hawk	23	1	1.09	1.00
Harlan's Hawk	3	0	0.67	n.d.
Rough-Legged Hawk	2	0	0.50	n.d.
Golden Eagle	6	0	0.33	n.d.
American Kestrel	13	1	0.38	1.00
Merlin	5	0	0.20	n.d.
Blue Grouse	7	0	1.14	n.d.
Willow Ptarmigan	2	1	2.00	1.00
Ruffed Grouse	2	0	0.50	n.d.
Lesser Golden-Plover	0	1	n.d.	3.00
Semipalmated Plover	6	0	1.67	n.d.
Killdeer	11	0	0.45	n.d.
Greater Yellowlegs	3	0	0.67	n.d.
Lesser Yellowlegs	21	2	6.71	4.50
Solitary Sandpiper	16	0	0.50	n.d.
Spotted Sandpiper	28	1	2.25	2.00
Upland Sandpiper	8	1	0.63	4.00
Least Sandpiper	7	0	0.29	n.d.
Common Snipe	30	2	1.67	7.50

Table A9. Summary of BBS indices for Northern B.C. and Yukon.

Species	Potential Routes 66-77	Potential Routes 78-83	Index 66-77	Index 78-83
Red-necked Phalarope	7	0	0.57	n.d.
Long-tailed Jaeger	0	1	n.d.	1.00
Bonaparte's Gull	17	2	3.29	3.50
Mew Gull	28	3	8.00	7.67
Herring Gull	25	1	4.92	4.00
Unidentified Gull	3	0	0.33	n.d.
Arctic Tern	22	1	1.68	1.00
Rock Dove	7	0	2.14	n.d.
Common Nighthawk	0	1	n.d.	9.00
Rufous Hummingbird	2	0	1.50	n.d.
Belted Kingfisher	12	0	0.50	n.d.
Yellow-bellied Sapsucker	5	0	0.20	n.d.
Downy Woodpecker	5	0	0.20	n.d.
Hairy Woodpecker	0	1	n.d.	1.00
Three-toed Woodpecker	4	0	1.00	n.d.
Yellow-shafted Flicker	27	2	4.96	1.50
Red-shafted Flicker	7	0	0.29	n.d.
Olive-sided Flycatcher	25	2	3.00	5.00
Western Wood-Pewee	28	2	5.29	18.50
Yellow-bellied Flycatcher	0	1	n.d.	2.00
Alder Flycatcher	27	4	4.19	36.00
Traill's Flycatcher Complex	3	0	1.00	n.d.
Least Flycatcher	12	0	0.42	n.d.
Hammond's Flycatcher	8	1	0.38	1.00
Dusky Flycatcher	0	1	n.d.	2.00
Unidentified Empidonax Sp.	2	0	0.50	n.d.
Say's Phoebe	10	1	0.40	1.00
Horned Lark	2	0	8.50	n.d.
Tree Swallow	27	0	1.67	n.d.
Violet-green Swallow	12	1	2.00	2.00
Bank Swallow	21	2	16.52	2.50
Cliff Swallow	20	1	15.65	8.00
Barn Swallow	10	0	2.80	n.d.
Gray Jay	29	4	14.90	9.50
Steller's Jay	2	0	0.50	n.d.
Common Raven	29	1	3.97	9.00
Black-capped Chickadee	23	0	0.57	n.d.
Boreal Chickadee	27	2	5.52	2.00
Chestnut-backed Chickadee	2	0	5.50	n.d.
Red-breasted Nuthatch	11	0	0.55	n.d.
Winter Wren	2	0	8.00	n.d.
Golden-crowned Kinglet	6	0	0.67	n.d.
Ruby-crowned Kinglet	31	3	3.03	3.33
Mountain Bluebird	22	0	1.27	n.d.
Townsend's Solitaire	15	1	1.07	1.00
Gray-cheeked Thrush	8	3	1.50	3.33
Swainson's Thrush	32	4	46.88	75.50

Table A9. Summary of BBS indices for Northern B.C. and Yukon.

Species	Potential Routes		Index	
	66-77	78-83	66-77	78-83
Hermit Thrush	30	3	5.33	39.33
American Robin	30	4	24.07	25.25
Varied Thrush	27	4	3.33	9.75
Water Pipit	2	0	8.00	n.d.
Bohemian Waxwing	29	3	7.76	3.00
European Starling	3	0	1.67	n.d.
Solitary Vireo	1	0	1.00	n.d.
Warbling Vireo	3	0	4.67	n.d.
Tennessee Warbler	5	0	1.20	n.d.
Orange-crowned Warbler	31	3	4.52	8.33
Yellow Warbler	26	3	2.58	5.33
Yellow-rumped Warbler	32	4	22.03	10.50
Townsend's Warbler	5	1	2.00	1.00
Palm Warbler	4	0	0.25	n.d.
Blackpoll Warbler	31	1	4.48	1.00
American Redstart	7	0	0.86	n.d.
Northern Waterthrush	17	3	0.94	3.00
MacGillivray's Warbler	20	0	1.60	n.d.
Common Yellowthroat	21	2	1.71	1.50
Wilson's Warbler	32	3	11.41	11.00
American Tree Sparrow	24	1	7.50	62.00
Chipping Sparrow	32	3	11.09	6.67
Savannah Sparrow	27	1	6.48	24.00
Fox Sparrow	13	4	1.92	11.75
Lincoln's Sparrow	25	4	4.36	14.25
Golden-crowned Sparrow	3	0	12.67	n.d.
White-crowned Sparrow	28	4	32.75	31.75
Slate-coloured Junco	29	4	56.72	72.25
Oregon Junco	2	0	2.00	n.d.
Lapland Longspur	0	1	n.d.	1.00
Snow Bunting	2	0	1.50	n.d.
Red-winged Blackbird	19	0	0.89	n.d.
Rusty Blackbird	18	0	1.56	n.d.
Brown-headed Cowbird	3	0	2.33	n.d.
Pine Grosbeak	15	0	1.73	n.d.
Purple Finch	3	0	0.67	n.d.
Red Crossbill	9	0	0.44	n.d.
White-winged Crossbill	25	3	8.72	2.67
Common Redpoll	27	2	8.63	13.00
Pine Siskin	32	2	9.91	3.50

Table A10. Summary of BBS indices for Newfoundland.

Species	Potential Routes		Index	
	66-77	78-83	66-77	78-83
Common Loon	2	1	3.50	3.00
American Bittern	3	0	2.33	n.d.
Common Goldeneye	1	0	2.00	n.d.
Common Merganser	2	0	0.50	n.d.
Red-breasted Merganser	2	0	2.00	n.d.
Osprey	3	0	1.00	n.d.
American Kestrel	1	0	2.00	n.d.
Semipalmated Plover	1	0	1.00	n.d.
Greater Yellowlegs	2	1	2.50	5.00
Spotted Sandpiper	7	1	3.14	1.00
Least Sandpiper	2	0	2.50	n.d.
Common Snipe	8	0	11.38	n.d.
Herring Gull	6	1	81.17	1.00
Great Black-backed Gull	8	1	23.13	7.00
Black-legged Kittiwake	1	0	23.00	n.d.
Common Tern	4	0	6.25	n.d.
Rock Dove	3	0	2.00	n.d.
Great Horned Owl	1	0	2.00	n.d.
Short-eared Owl	2	0	1.00	n.d.
Belted Kingfisher	5	0	1.20	n.d.
Downy Woodpecker	2	1	0.50	4.00
Hairy Woodpecker	1	1	1.00	2.00
Black-backed Woodpecker	1	1	1.00	1.00
Yellow-shafted Flicker	4	1	1.00	2.00
Olive-sided Flycatcher	3	0	1.67	n.d.
Yellow-bellied Flycatcher	9	1	25.89	33.00
Least Flycatcher	0	1	n.d.	1.00
Horned Lark	6	0	5.00	n.d.
Tree Swallow	7	1	4.71	7.00
Gray Jay	4	1	5.25	5.00
American Crow	9	1	17.78	19.00
Common Raven	7	1	3.43	5.00
Black-capped Chickadee	4	1	1.75	1.00
Boreal Chickadee	5	1	0.60	4.00
Red-breasted Nuthatch	1	0	1.00	n.d.
Winter Wren	7	0	3.71	n.d.
Ruby-crowned Kinglet	9	1	12.00	20.00
Gray-cheeked Thrush	9	1	18.00	3.00
Swainson's Thrush	5	1	8.60	9.00
Hermit Thrush	6	1	9.50	9.00
American Robin	9	1	62.22	38.00
European Starling	7	0	7.00	n.d.
Tennessee Warbler	5	1	2.00	15.00
Yellow Warbler	7	1	19.43	9.00
Magnolia Warbler	5	1	3.80	7.00

Table A10. Summary of BBS indices for Newfoundland.

Species	Potential Routes		Index	
	66-77	78-83	66-77	78-83
Yellow-rumped Warbler	8	1	3.00	75.00
Black-throated Green Warbler	4	1	0.75	8.00
Palm Warbler	0	1	n.d.	6.00
Blackpoll Warbler	9	1	37.56	35.00
Black-and-white Warbler	6	1	2.83	13.00
American Redstart	2	1	2.50	9.00
Ovenbird	2	1	0.50	9.00
Northern Waterthrush	9	1	38.11	23.00
Mourning Warbler	8	1	17.00	9.00
Common Yellowthroat	5	1	5.60	4.00
Wilson's Warbler	9	1	11.33	11.00
Rose-breasted Grosbeak	0	1	n.d.	1.00
Savannah Sparrow	6	0	14.17	n.d.
Fox Sparrow	9	1	39.78	10.00
Lincoln's Sparrow	7	1	27.14	31.00
Swamp Sparrow	8	1	8.38	1.00
White-throated Sparrow	9	1	46.44	86.00
White-crowned Sparrow	1	0	25.00	n.d.
Slate-coloured Junco	4	1	12.50	4.00
Rusty Blackbird	9	1	2.44	2.00
Pine Grosbeak	7	1	1.86	1.00
Purple Finch	7	1	3.00	7.00
Red Crossbill	1	1	1.00	5.00
White-winged Crossbill	2	1	3.00	7.00
Common Redpoll	4	0	9.75	n.d.
Pine Siskin	7	1	1.71	14.00
House Sparrow	2	0	7.00	n.d.

Appendix B - Summary of waterfowl population indices in the prairie provinces from U.S. Fish and Wildlife surveys over the two time periods 1966-1977 and 1978-1983.

To allow a comparison with BBS results, the counts from aerial surveys of waterfowl have been grouped into regions roughly corresponding to BBS routes Southern Prairie Provinces (aerial survey strata 28, 29, 32, 33, 34, 35, 38, 39 and 40) and Central Prairie Provinces (Aerial survey strata 19, 20, 21, 22, 23, 24, 25, 26, 27, 30, 31, 36 and 37). The population estimates from the aerial surveys, which are given in units of thousands of birds, are averaged for the two time periods, 1966-1977 and 1978-1983. Data were provided by the U. S. Fish and Wildlife Service.

Species	Region	Index 66-77	Index 78-83
Mallard	Central	3965	3332
	Southern	1998	1558
Blue-winged Teal	Central	1772	1626
	Southern	1645	1054
Northern Pintail	Central	1481	841
	Southern	2034	1304
Lesser Scaup	Central	2108	2533
	Southern	331	478
American Coot	Central	880	1047
	Southern	709	631